US ARMY CORPS OF ENGINEERS
NORTHWESTERN DIVISION

Technical Management Team
2006 Year End Review

Water Quality

Fixed Monitoring Stations

- Corps operated a total of 28 FMS’s
  - Portland District: 8 Stations
  - Walla Walla District: 15 Stations
  - Seattle District: 5 Stations
- Bureau of Reclamation Operated 4 FMS’s
- Mid-C PUD’s Operated 10 FMS’s
- Removed Station for 2006
  - Removed McNary Forebay (Oregon Side) in April.
- Data can be obtained at “Dataquery”
  - http://www.nwd-wc.usace.army.mil/perl/dataquery.pl

Total Dissolved Gas

Project	Start of Spill	End of Spill	Days of Spill
Lower Granite	3 April	31 August	151 Days
Little Goose	3 April	31 August	151 Days
Lower Monumental	3 April	31 August	151 days
Ice Harbor	3 April	31 August	151 days
McNary	10 April	31 August	144 days
John Day	10 April	31 August	144 days
The Dalles	10 April	31 August	144 days
Bonneville	10 April	31 August	144 days

Snake River Spill Operations

Project	Spring (April 3 – June 20)	Summer (June 21 – August 31)
Lower Granite	20 kcfs (RSW with training spill)	18 kcfs (RSW with training spill)
Little Goose	To the spill cap up to 30% of project outflow.	To the spill cap up to 30% of project outflow.
Lower Monumental	To the spill cap up to 40 kcfs.	To the spill cap up to 17 kcfs.
Ice Harbor	Daytime(0500-1800): 45 kcfs Nighttime(1800-0500): To the spill cap.	Alternate between 30% of outflow 24 hrs per day and 45 kcfs Daytime/To the spill cap at night.

Columbia River Spill Operations

Project	Spring (April 10 – June 30)	Summer (July 1 – August 31)
McNary	4/10-4/22: 0 kcfs daytime/To the spill cap at night. 4/23-6/19: Alternate between 40% of outflow, 24 hrs per day and 0 kcfs daytime/To the spill cap at night.	Alternate between 40% and 60% of outflow (up to the spill cap), 24 hrs per day. (6/20-8/31)
John Day	0 kcfs daytime (0600-1800)/To the spill cap up to 60% of outflow at night.	To the spill cap up to 30% of outflow, 24 hrs per day.
The Dalles	To the spill cap up to 40% of outflow, 24 hrs per day.	To the spill cap up to 40% of outflow, 24 hrs per day.
Bonneville	To the spill cap up to 100 kcfs.	75 kcfs daytime/To the spill cap at night.

Total Dissolved Gas

Comparison of Exceedences with Previous Years

TDG Exceedences from High 12-hr Average in 24 hours

Year	Gauge-Days in Spill Season[H]	Gauge-Days of BiOp Spill in Spill Season	Number of Days Exceeded	Percent of Days Exceeding TDG Standard	
				All Spill	BiOp Spill
2006	2504[']	2504[']	575	23.0%	23.0%
2005	2639	2124	69	2.6%	3.2%
2004	2639	1591	71	2.7%	4.5%
2003	2639	1936	243	9.2%	12.6%
2002	2639	2039	490	18.6%	24.0%
2001	2639	398	13	0.5%	3.3%
Ave.	**--**	**--**	**245**	**9.5%**	**8.2**

[H] Spill Season begins on April 3rd (Snake) and April 10th (Columbia) and ends on August 31st.

['] Based on 17 TDG gauges (removed MCN Forebay (Oregon Side) in 2006). All other years based on 18 TDG gauges.

Total Dissolved Gas

US ARMY CORPS OF ENGINEERS NORTHWESTERN DIVISION

AVERAGE HIGH 12 HR %TDG EXCEEDANCES AT FMS FROM 1999 - 2006									
	2006	2005	2004	2003	2002	2001	2000	1999	Totals
Water Quality Gages	**Qty.**	**Qty.**	**Qty.**	**Qty.**	**Qty.**	**Qty.**	**Qty.**	**Qty.**	**Qty.**
Lower Granite Forebay *	0	0	0	0	0	5	2	0	7
Lower Granite Tailwater	28	0	0	15	17	0	4	15	79
Little Goose Forebay *	24	0	3	10	17	0	2	39	95
Little Goose Tailwater	19	0	0	6	6	0	9	6	46
Lower Monumental Forebay *	56	6	1	19	49	0	28	44	203
Lower Monumental Tailwater	29	7	1	10	6	0	12	26	91
Ice Harbor Forebay *	51	3	4	35	24	0	34	44	195
Ice Harbor Tailwater	22	3	2	4	6	0	4	12	53
McNary Forebay - Wa. *	31	8	10	24	43	1	14	22	153
McNary Forebay - Or.	--	11	23	32	45	5	22	19	157
McNary Tailwater	32	1	7	12	31	0	17	50	150
John Day Forebay	20	2	0	10	11	0	1	8	52
John Day Tailwater	38	3	0	0	29	0	12	43	125
The Dalles Forebay	40	6	5	11	18	0	5	1	86
The Dalles Tailwater	10	0	0	4	11	0	5	5	35
Bonneville Forebay	51	3	1	17	30	0	14	19	135
Cascade Island	61	0	---	---	---	---	---	---	61
Warrendale	--	---	0	1	19	0	6	2	28
Camas/Washougal	63	16	14	33	65	2	58	51	302
Total Number of Exceedances	**575**	**69**	**71**	**243**	**427**	**13**	**249**	**406**	2053

* New Forebay gages set at 15 m depth. Previous gage set at 5 m depth (Beginning 2005).

Total Dissolved Gas

TYPES OF EXCEEDANCES

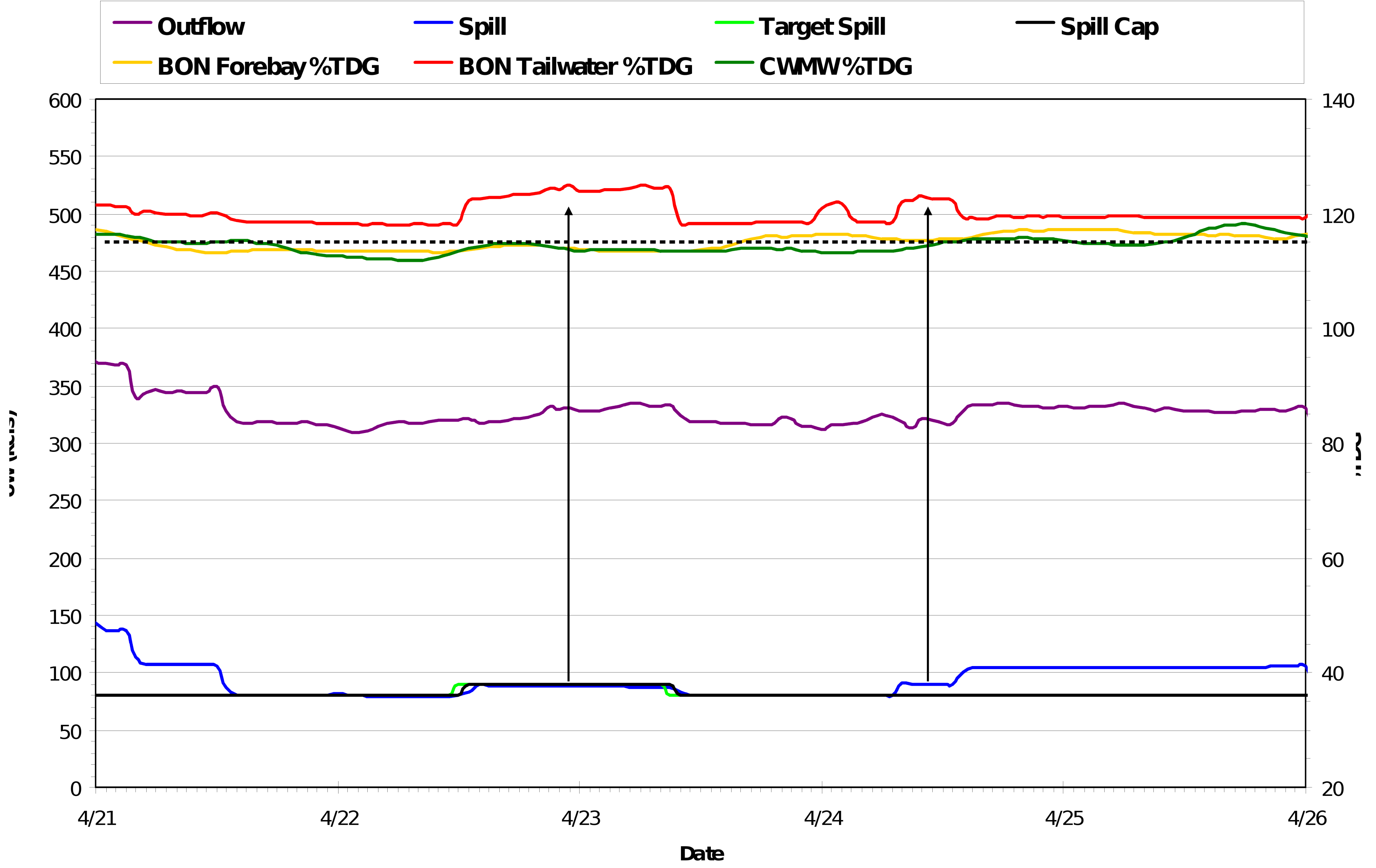
FOR 2003 - 2006 SPILL SEASONS

4 Year Totals	2006	2005	2004	2003	TYPE #	DEFINITION
389	306	11	4	68	1	Exceedance due to high runoff flows and flood control efforts.
0	0	0	0	0	2	Exceedance due to Intertie line outages.
45	45	0	0	0	3	Exceedance due to unit outages during repair or maintenance.
109	106	3	0	0	4	Exceedance due to BPA inability to handle load so water was spilled.
1	0	0	0	1	5	Exceedance due to a break down in communication. Teletype went out but no change occurred or Project operator interpreted teletype differently than what was intended.
223	69	32	16	106	6	Exceedance due to uncertainties when using best professional judgment to apply the spill guidance criteria (travel time; degassing; water temperature effects; spill patterns).
62	29	15	0	18	7	Exceedance due to high TDG levels coming from the Mid Columbia River Dam (see Pasco FMS readings).
3	0	0	3	0	8	Exceedance due to high TDG levels coming from the Snake River projects (see Ice Harbor Dam FMS readings).
0	0	0	0	0	9	Exceedance due to a load rejection. The powerhouse was not working and the river was spilled.
15	1	1	6	7	10	Exceedance due to lack of information: the FMS gage malfunctioning and we had no information at the time of making spill change decisions.
9	0	0	0	9	11	Exceedance due to mechanical problems (gate was stuck open, passing debris etc.).
55	3	7	25	20	12	Exceedance due to sharp rise in water temperature (a 3 degree F. or greater change in a day).
43	3	0	7	33	13	Exceedance due to bulk spill pattern being used which generated more TDG than expected.
13	13	0	0	0	14	Exceedance due to non-functioning of flow deflectors during tailwater elevation above 19 ft and especially above 26 ft.
10	0	0	10	0	12/7	Exceedance due to combination of exceedance type 12 and 7.
402	**575**	**69**	**71**	**262**		**Totals**

Bonneville Spill Patterns

- New spill patterns developed for spill flows less than 100 kcfs.
  - Increased spill at outer spill bays (1-3 & 16-19).
  - Resulted in high TDG levels at CCIW.
  - CCIW likely overestimated net TDG production in spillway channel.
- Resulted in avoiding spill caps that would result in spill between 85 and 100 kcfs.
- High tailwaters exacerbated this problem.

2006 Spring Spill - Bonneville Dam

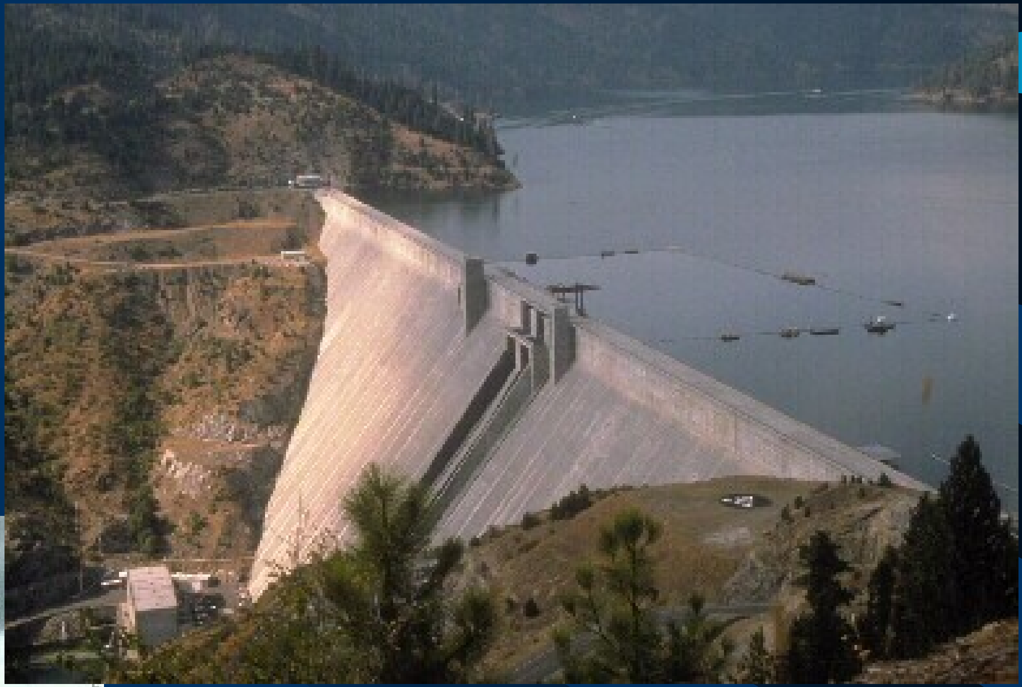


Target Spill = Quantity of Spill specified in the Fish Passage Implementation Plan.

Spill Cap = Maximum amount of spill that will keep TDG levels below State TDG Criteria.

Dworshak Summer Operations

US ARMY CORPS OF ENGINEERS
NORTHWESTERN DIVISION



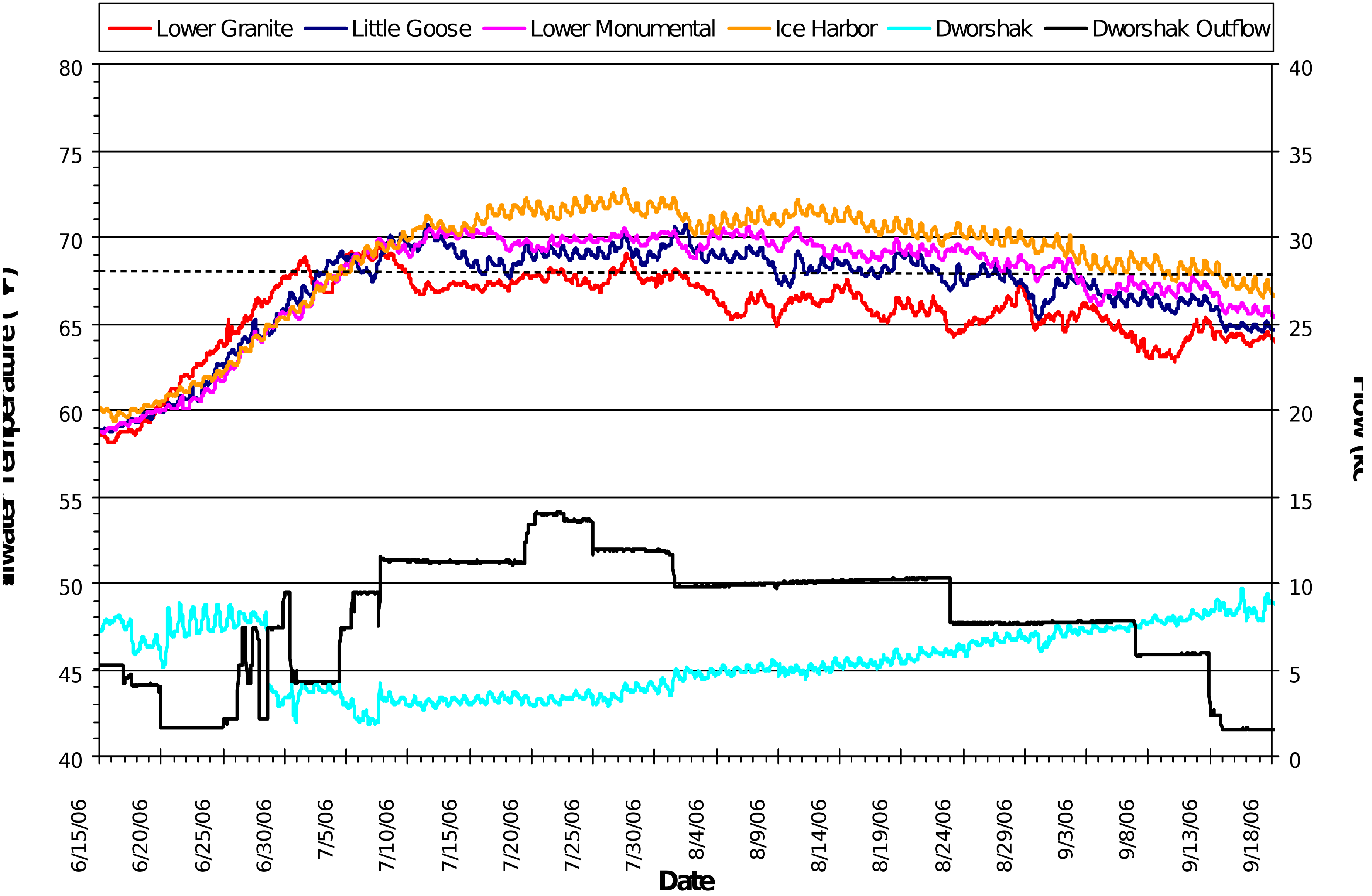
Dworshak Dam

Lower Granite Dam Tailwater

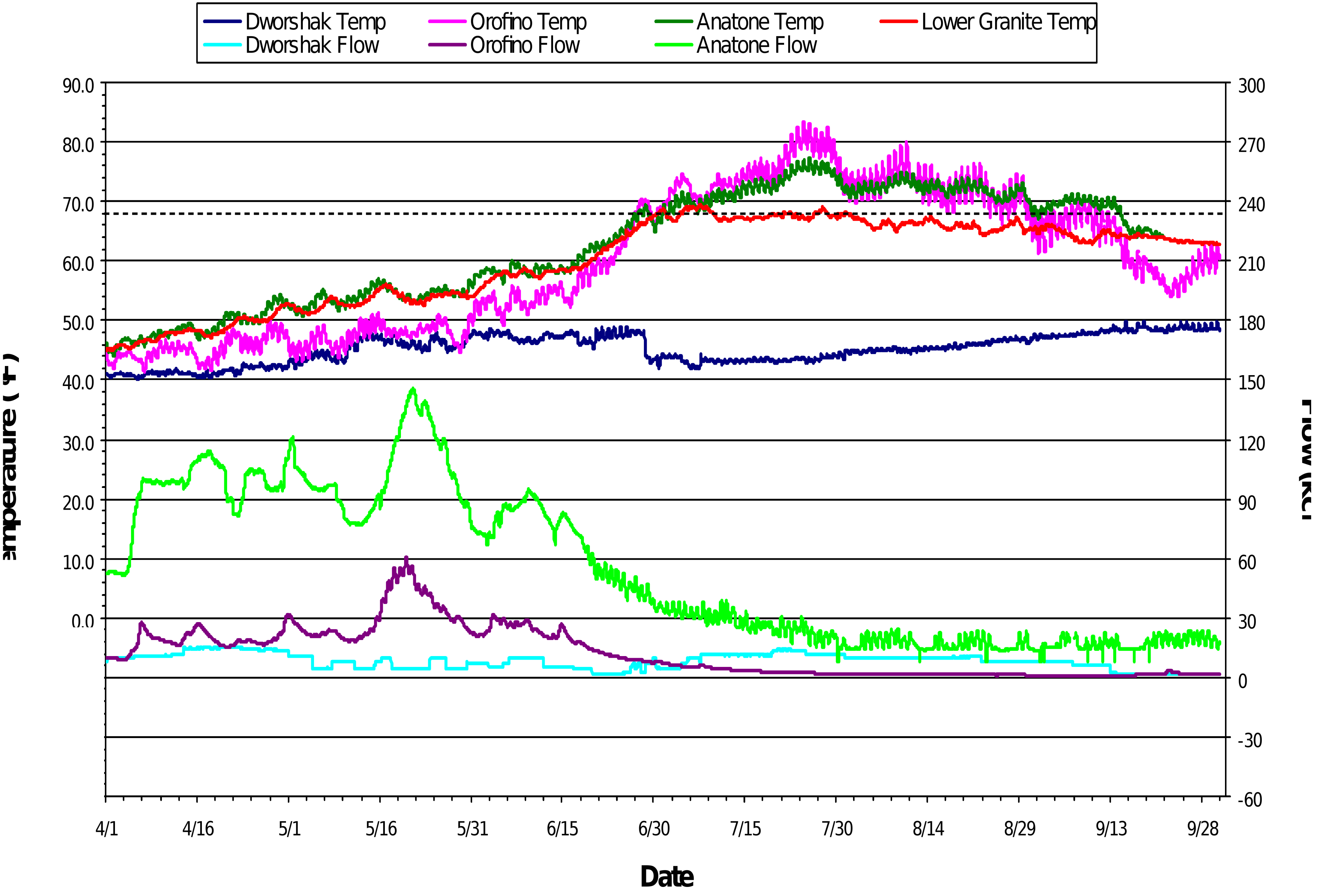
Dworshak Summer Operations

Operation Start		Operation End				Selector Gate Position		
Date	Time (hrs)	Date	Time (hrs)	Outflow (kcfs)	Ouflow Target Temperature (°F)	Small Unit	Small Unit	Big Unit
28 June	1600	29 June	2200	7.3 – 7.5	42.5 – 43.5	O	--	U
29 June	2200	30 June	1100	9.3 – 9.5	42.5 – 43.5	O	U	U
30 June	1100	4 July	1200	4.2 – 4.3	42.5 – 43.5	O	U	--
4 July	1200	5 July	1100	7.4	42.5 – 43.5	O	--	U
5 July	1100	7 July	1600	9.4 – 9.5	42.5 – 43.5	O	U	U
7 July	1600	July 19	1200	11.2 – 11.4	42.5 – 43.5	O	U	U
19 July	1200	24 July	2100	13.6 – 14.0	42.5-43.5	O	U	U
24 July	2100	31 July	1100	11.9 – 12.0	Lowest Possible	U	U	U
31 July	1100	22 Aug	2200	9.8 – 10.3	Lowest Possible	U	U	U
22 Aug	2200	6 Sep	2200	7.7 – 7.8	Lowest Possible	--	U	U
6 Sep	2200	12 Sep	2200	5.9 – 6.0	Lowest Possible	--	--	U
12 Sep	2200	13 Sep	2200	2.4	Lowest Possible	U	--	--
13 Sep	2200	End of Season		1.5	Lowest Possible	U	--	--

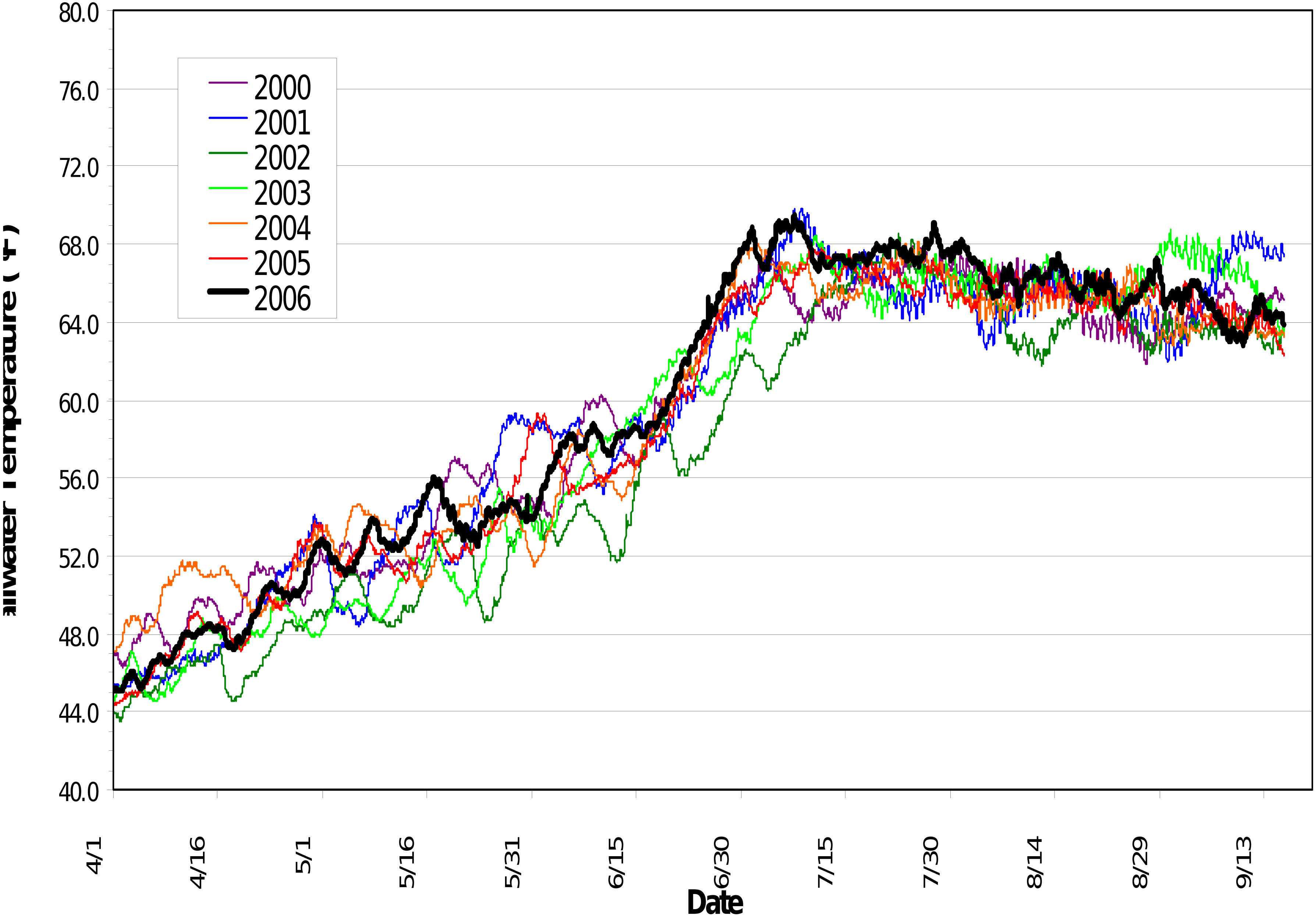
Dworshak Outflows and Lower Snake River Tailwater Temperatures in 2006
(June 15th - September 18th)



Lower Granite Inflows and Temperatures in 2006



Lower Granite Tailwater Temperatures 2000-2006



Dworshak Summer Operations

Lower Granite Tailwater FMS Temperature Analysis

Year	Hours of Exceedance	Cumulative Magnitude of Exceedance (°F)
2006	223	131
2005	0	0
2004	7	1
2003	63	8
2002	17	2
2001	172	68
2000	0	0
1999	23	4
199	981	956

12-Year Statistics

Hours of Exceedance	
Range:	**Average:**
High: 981 hrs (1998)	**12-Yr Ave: 249 hrs**
Low: 0 hrs (2000, 2005)	**1995-1999: 452 hrs**
	2000-2005: 80

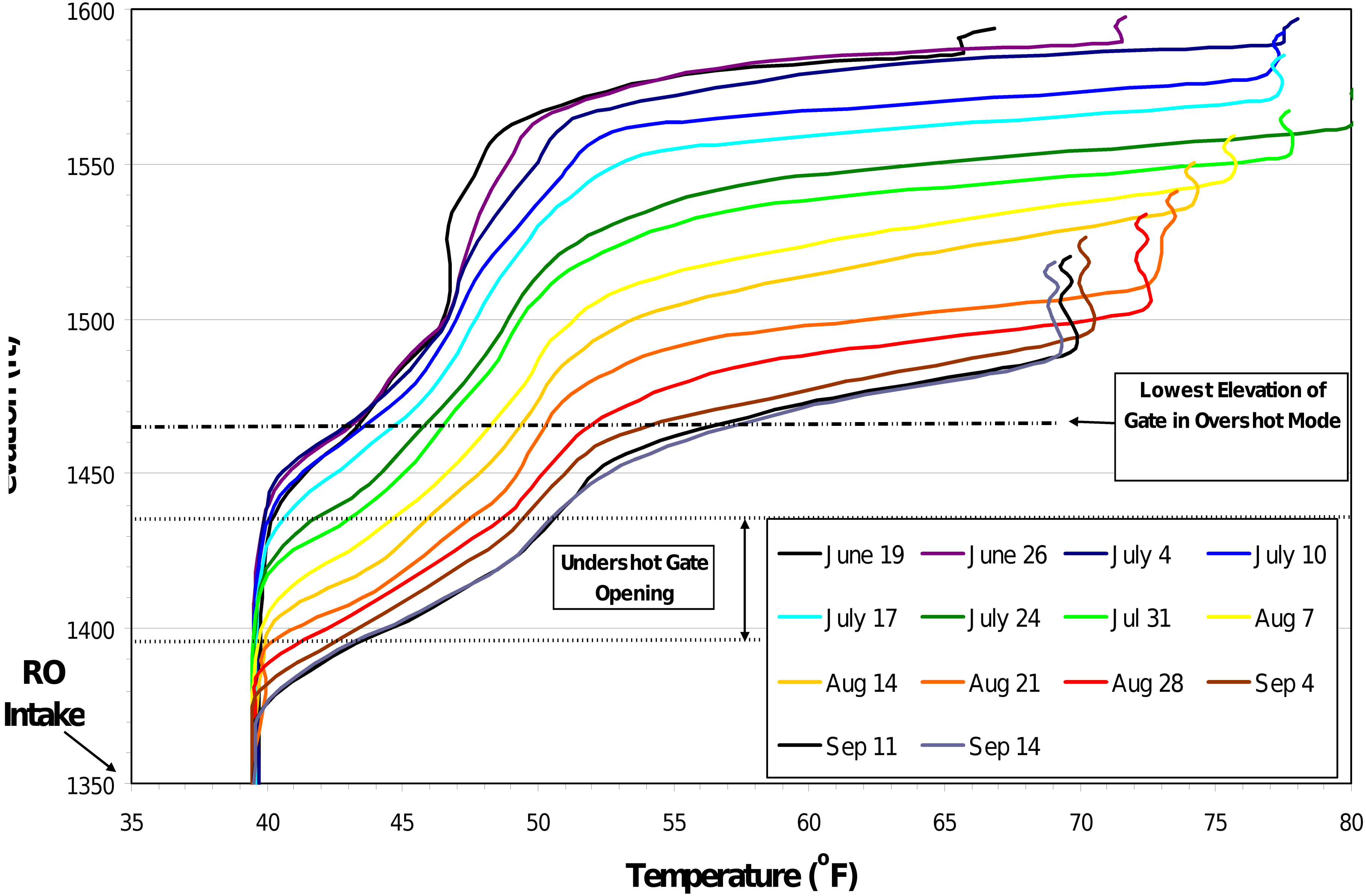
Cumulative Magnitude of Exceedance	
Range:	**Average:**
High: 1,721 deg-hrs (1998)	**12-Yr Ave: 303 deg-hrs**
Low: 0 deg-hrs (2000, 2005)	**1995-1999: 552 deg-hrs**
	2000-2005: 46 deg-hrs

Cumulative Magnitude of Exceedance

# hours temp exceeds 68 °F standard) x (Number of degrees above 68 °F standar

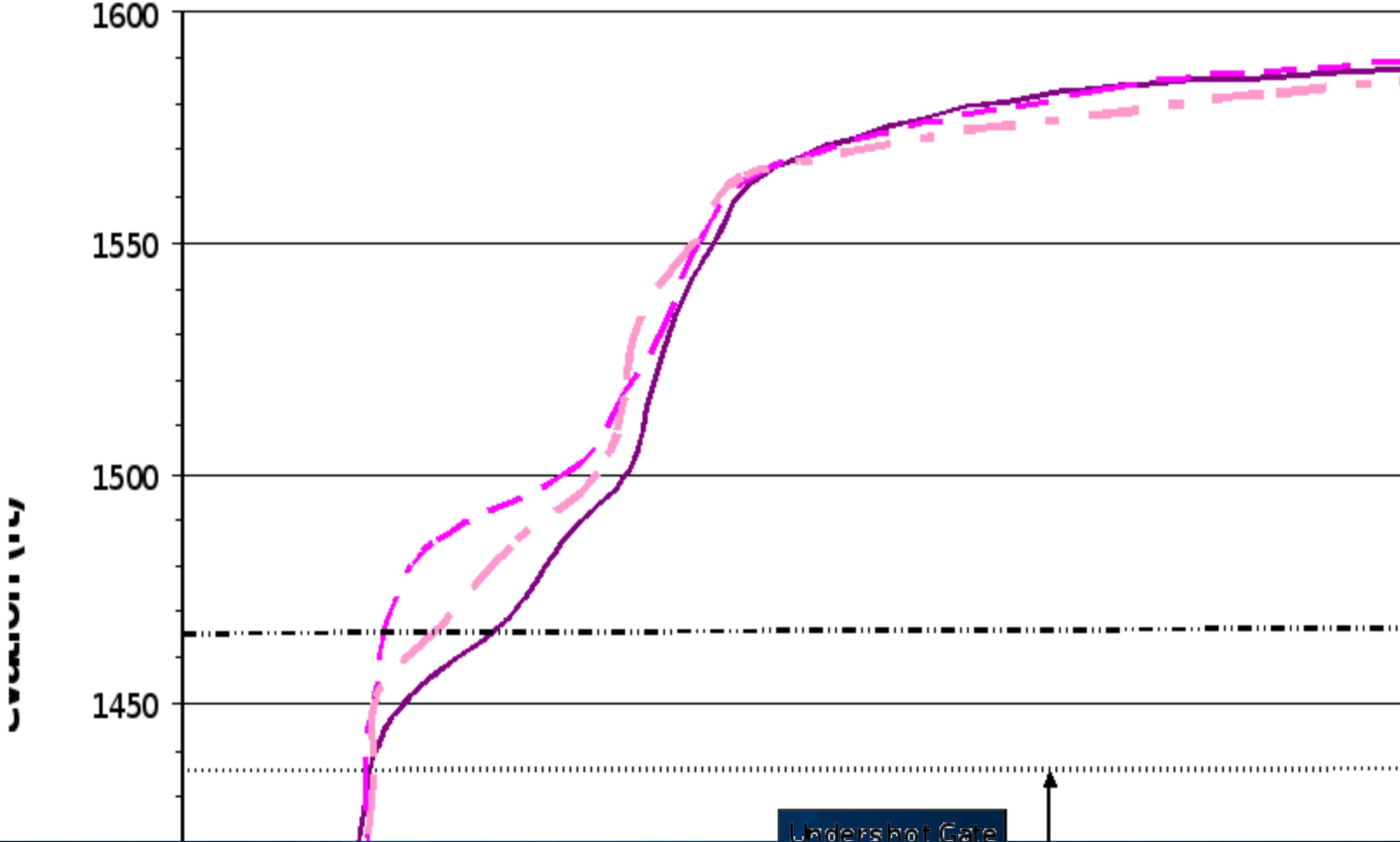
Dworshak Forebay Thermocline 2006

(Data from Floating Temperature Stringer DWR_S1)



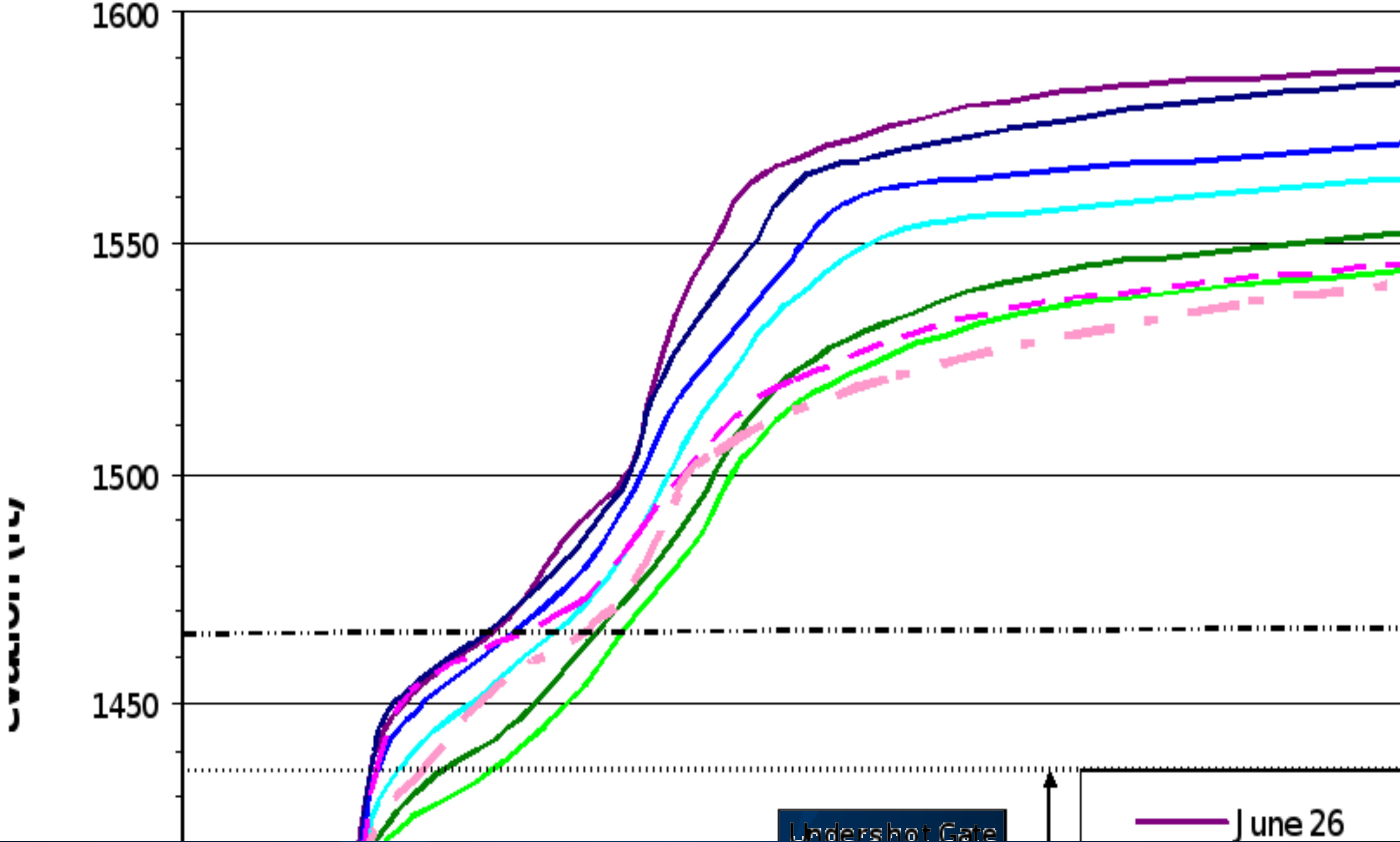
Dworshak Forebay Thermocline 20

(Data from Floating Temperature Stringer DWR_S



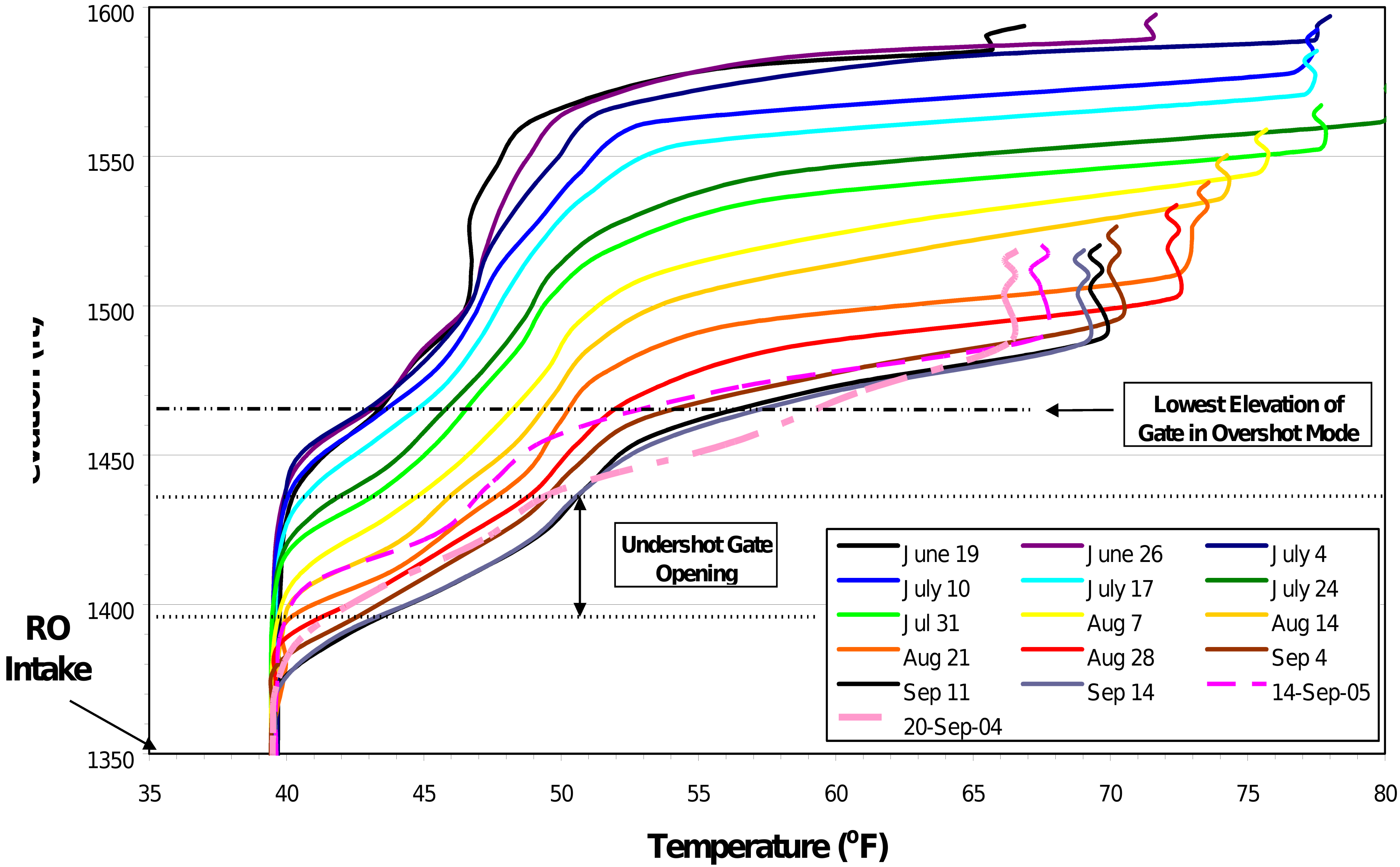
Dworshak Forebay Thermocline 20

(Data from Floating Temperature Stringer DWR_S



Dworshak Forebay Thermocline 2006

(Data from Floating Temperature Stringer DWR_S1)



US ARMY CORPS OF ENGINEERS
NORTHWESTERN DIVISION

Technical Management Team 2006 Year End Review

Water Quality

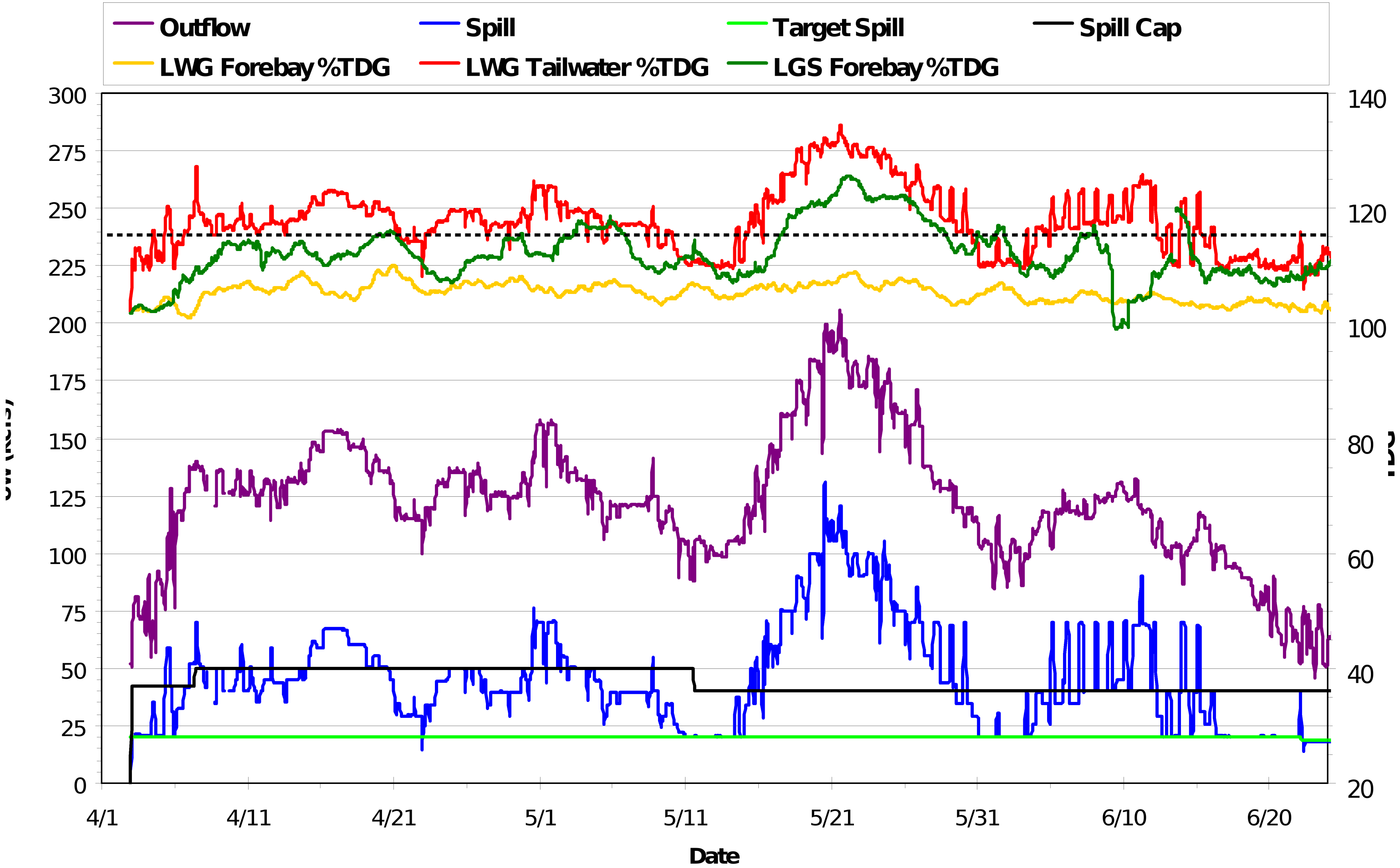
Individual Project Operations

Lower Granite Spill Activities in 2006

2006 Fish Passage Implementation Pla

- Spring Spill (April 3 – June 20)
  - ❖20 Kcfs RSW Spill
- Summer Spill (June 21 – August 31)
  - ❖18 Kcfs RSW Spill

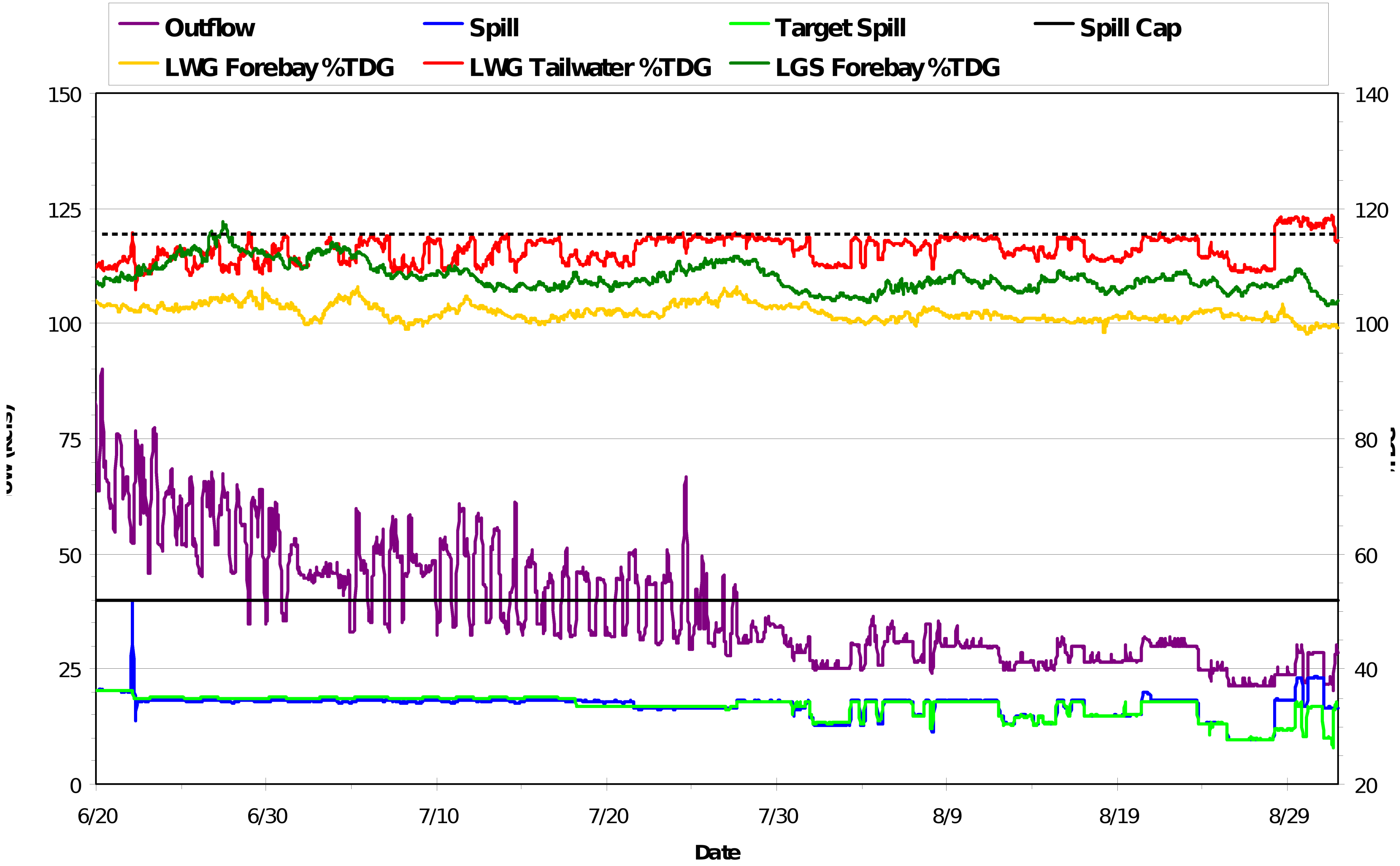
2006 Spring Spill - Lower Granite Dam



Target Spill = Quantity of Spill specified in the Fish Passage Implementation Plan.

Spill Cap = Maximum amount of spill that will keep TDG levels below State TDG Criteria.

2006 Summer Spill - Lower Granite Dam



Target Spill = Quantity of Spill specified in the Fish Passage Implementation Plan.

Spill Cap = Maximum amount of spill that will keep TDG levels below State TDG Criteria.

Lower Granite
2006 TDG Stats

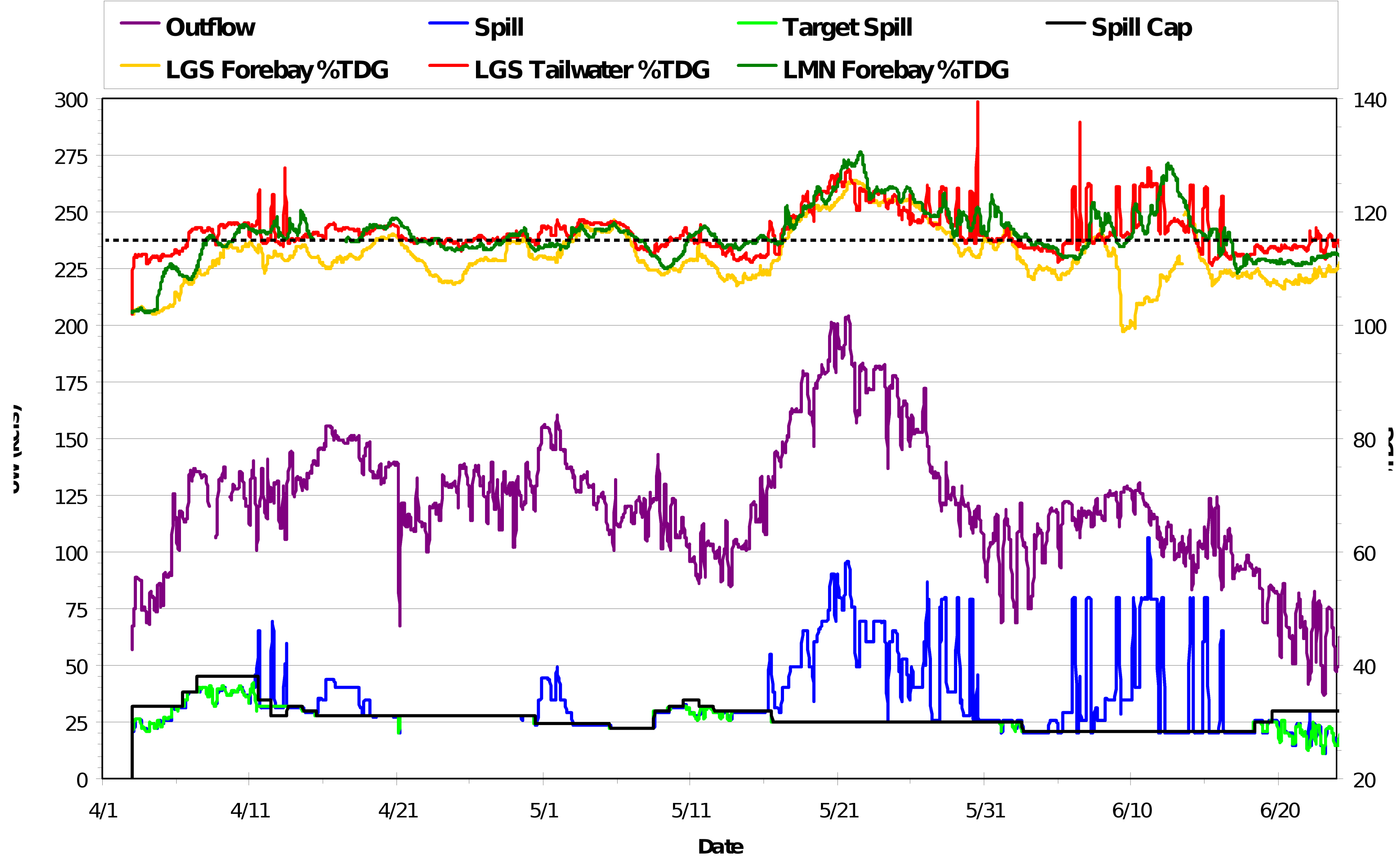
Parameter	Lower Granite Forebay (LWG)	Lower Granite Tailwater (LGNW)	Little Goose Forebay (LGSA)
Number of High 12-hr %TDG Exceedances	0	28	24
Number of Hourly Exceedances of 125% TDG Criteria	0	215	23
Peak %TDG	110.03%	134.5%	125.7%
Hours TDG:	---	---	---
> 110%	1 (0.0%)	3,264 (90.1%)	1638 (45.2%)
> 115%	0 (0.0%)	1,606 (44.3%)	501 (13.8%)
> 120%	0 (0.0%)	556 (15.3%)	188 (5.2%)
> 125%	0 (0.0%)	215 (5.9%)	23 (0.6%)
> 130%	0 (0.0%)	91 (2.5%)	0 (0.0%)
> 135%	0 (0.0%)	0 (0.0%)	0 (0.0%)

Little Goose Spill Activities in 2006

2006 Fish Passage Implementation P

- Spring Spill (April 3 – June 20)
  - 30% of Total Outflow, 24 Hrs per day.
- Summer Spill (June 21 – August 31)
  - 30% of Total Outflow, 24 Hrs per day.

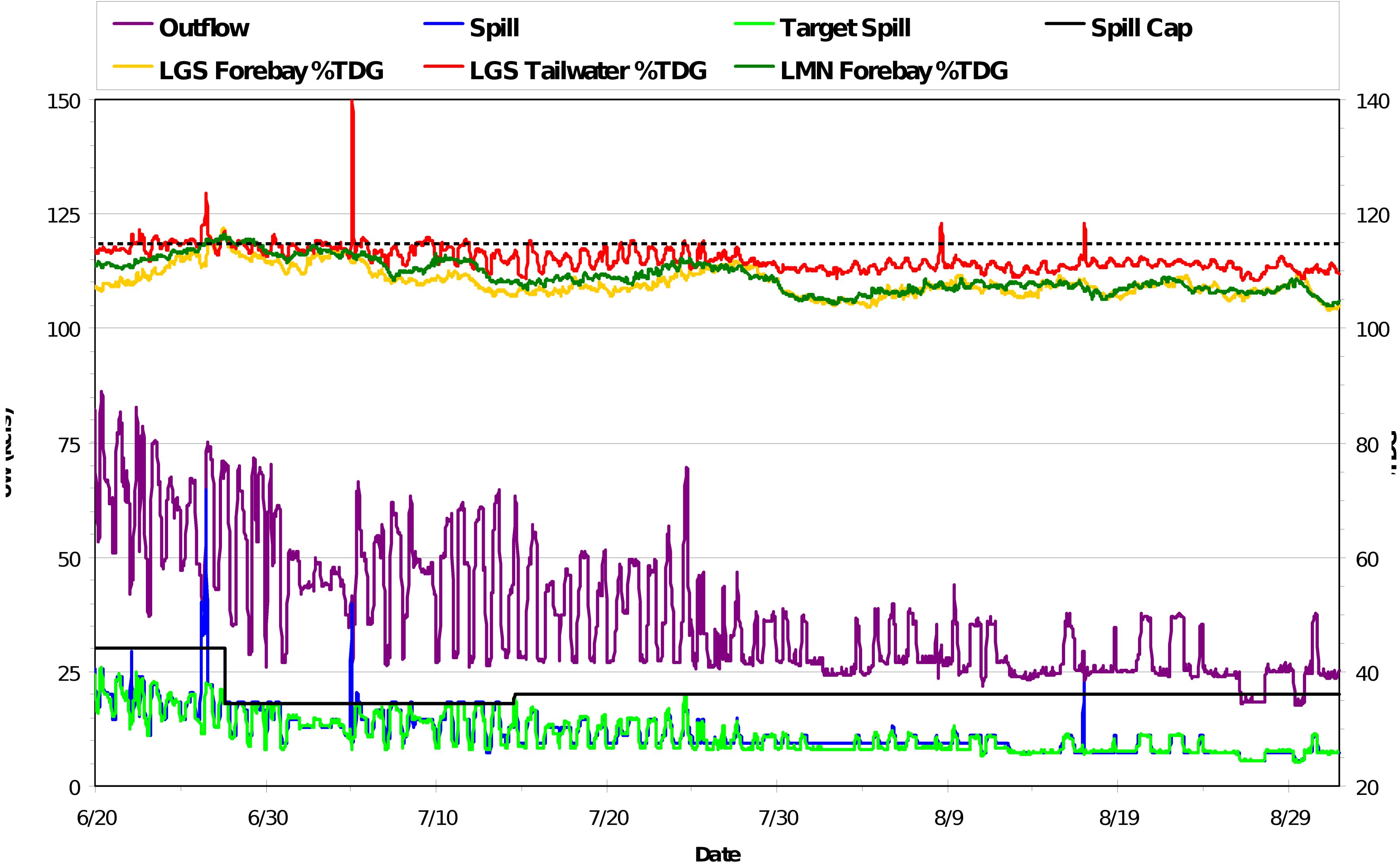
2006 Spring Spill - Little Goose Dam



Target Spill = Quantity of Spill specified in the Fish Passage Implementation Plan.

Spill Cap = Maximum amount of spill that will keep TDG levels below State TDG Criteria.

2006 Summer Spill - Little Goose Dam



Target Spill = Quantity of Spill specified in the Fish Passage Implementation Plan.

Spill Cap = Maximum amount of spill that will keep TDG levels below State TDG Criteria.

Little Goose 2006 TDG Stats

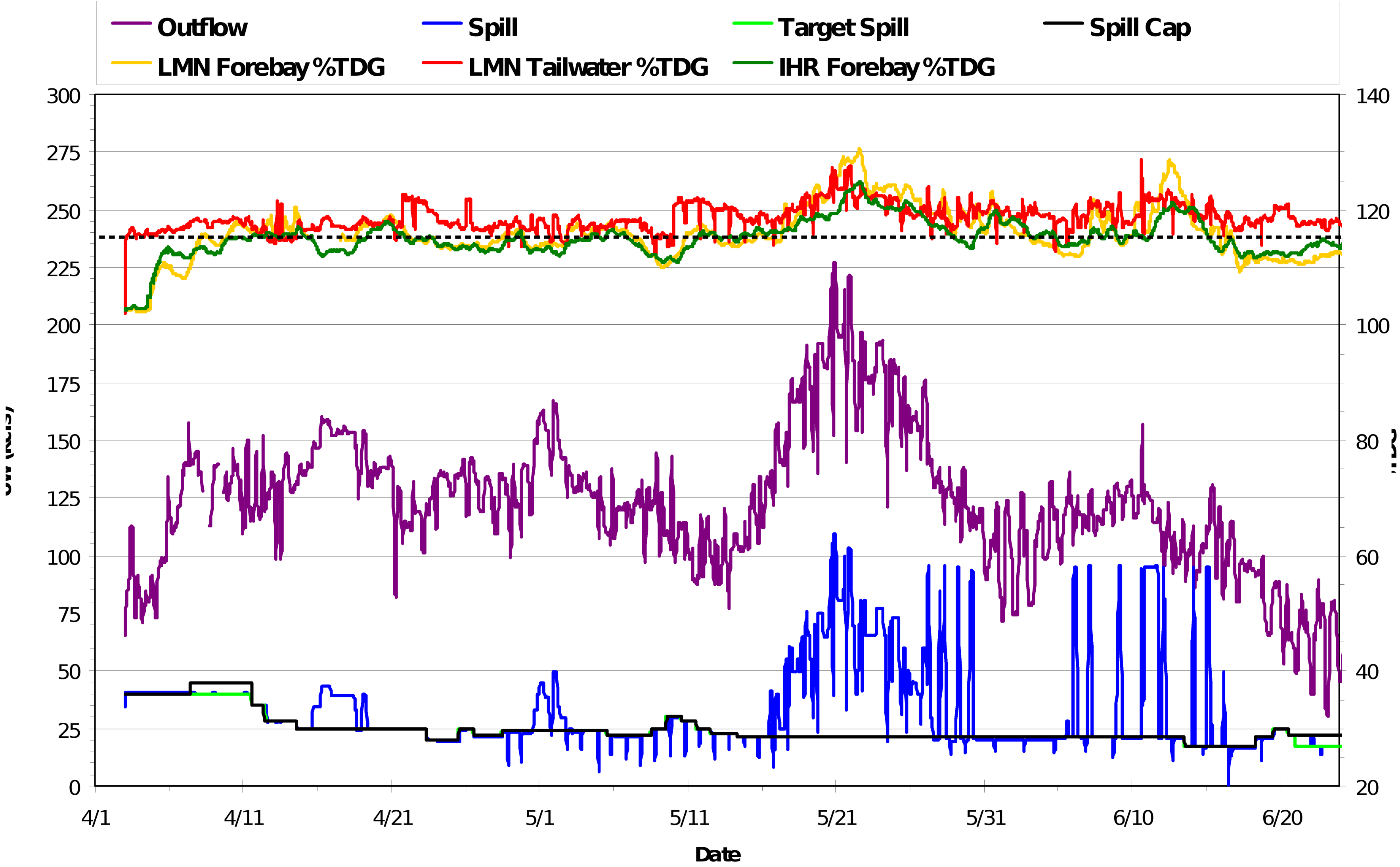
Parameter	Little Goose Forebay (LGSA)	Little Goose Tailwater (LGSW)	Lower Monumental Forebay (LMNA)
Number of High 12-hr %TDG Exceedances	24	18	56
Number of Hourly Exceedances of 125% TDG Criteria	23	45	74
Peak %TDG	125.7%	127.9%	130.6%
Hours TDG:	---	---	
> 110%	1638 (45.2%)	3444 (95.0%)	2358 (65.1%)
> 115%	501 (13.8%)	1329 (36.7%)	1132 (31.2%)
> 120%	188 (5.2%)	301 (8.3%)	310 (8.6%)
> 125%	23 (0.6%)	51 (1.4%)	74 (2.1%)
> 130%	0 (0.0%)	0 (0.0%)	4 (0.1%)

Lower Monumental Spill Activities in 2006

2006 Fish Passage Implementation P

- **Spring Spill (April 3 – June 20)**
  - ❖ **To the spill cap up to 40 kcsf.**
- **Summer Spill (June 21 – August 31)**
  - ❖ **To the spill cap up to 17 kcfs.**

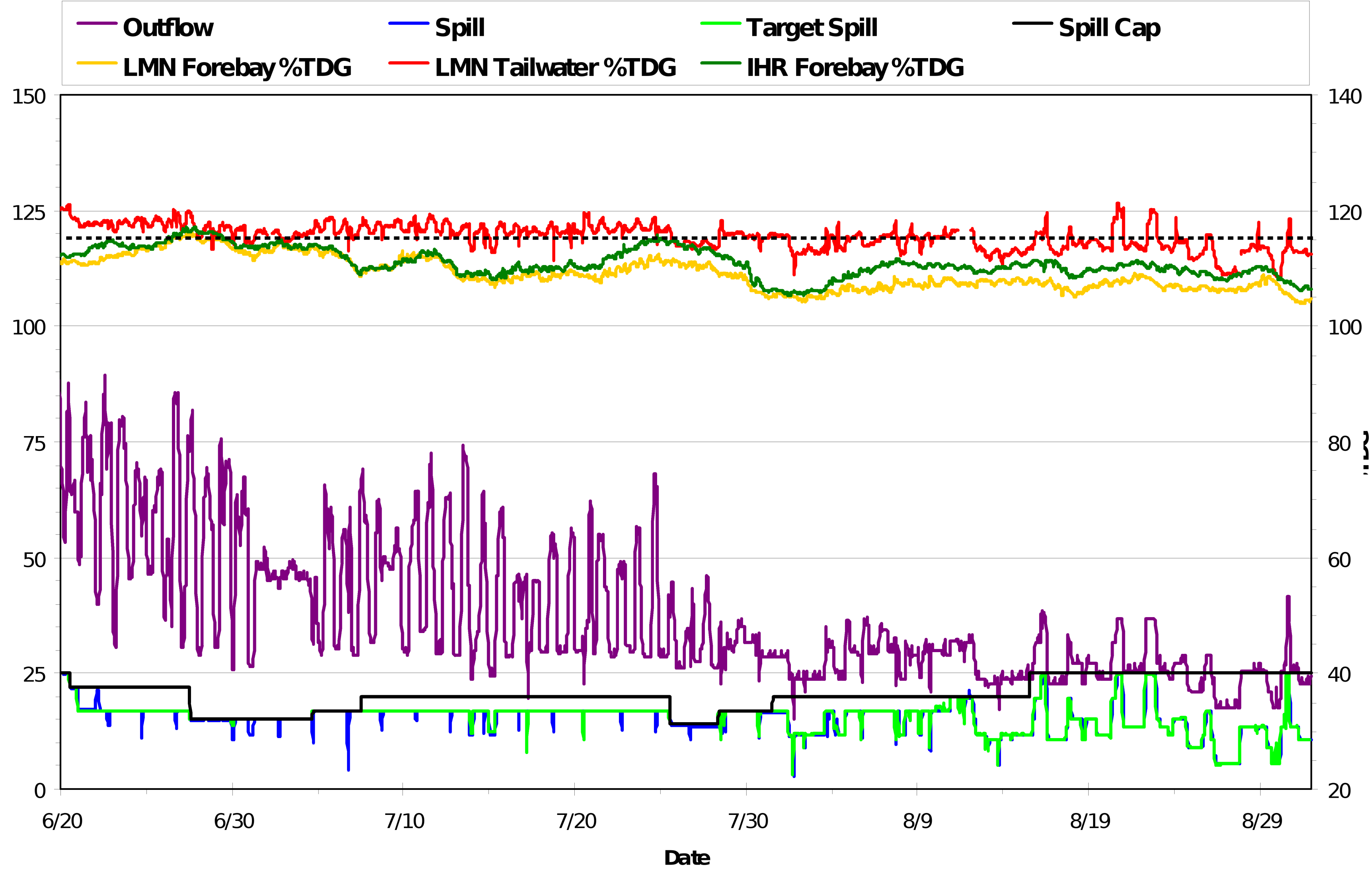
2006 Spring Spill - Lower Monumental Dam



Target Spill = Quantity of Spill specified in the Fish Passage Implementation Plan.

Spill Cap = Maximum amount of spill that will keep TDG levels below State TDG Criteria.

2006 Spring Spill - Lower Monumental Dam



Target Spill = Quantity of Spill specified in the Fish Passage Implementation Plan.

Spill Cap = Maximum amount of spill that will keep TDG levels below State TDG Criteria.

Lower Monumental TDG Stats 2006

Parameter	Lower Monumental Forebay (LMNA)	Lower Monumental Tailwater (LMNW)	Ice Harbor Forebay (IHRA)
Number of High 12-hr %TDG Exceedances	56	29	51
Number of Hourly Exceedances of 125% TDG Criteria	74	20	0
Peak %TDG	130.6%	128.8%	124.9
Hours TDG:	---	---	---
> 110%	2358 (65.1%)	3555 (98.1%)	2942 (81.2%)
> 115%	1132 (31.2%)	2864 (79.0%)	1058 (29.2%)
> 120%	310 (8.6%)	517 (14.3%)	145 (4.0%)
> 125%	74 (2.1%)	20 (0.6%)	0 (0.0%)
> 130%	4 (0.1%)	0 (0.0%)	0 (0.0%)
> 135%	0 (0.0%)	0 (0.0%)	0 (0.0%)

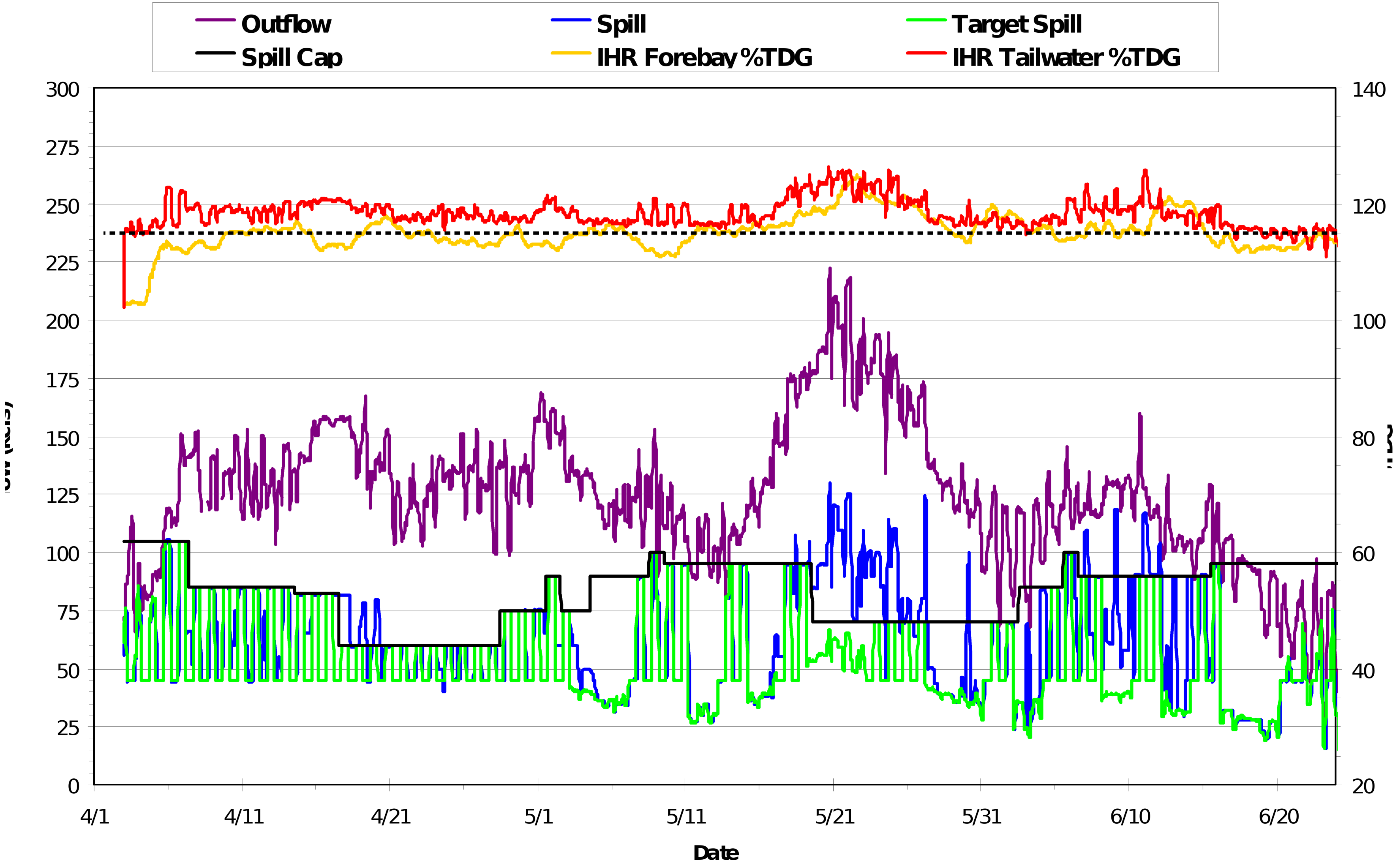
Ice Harbor Spill Activities in 2006

2006 Fish Passage Implementation P

- Spring Spill (April 3 – June 20)
  - ❖Daytime (0500-1800 hrs) – 45 kcfs
  - ❖Nighttime (1800-0500 hrs) – To the Spill Cap.

- Summer Spill (June 21 – August 31)
  - ❖Alternate between 30% of outflow 24 hrs/day and 45 kcfs Daytime/to the Spill Cap at night.

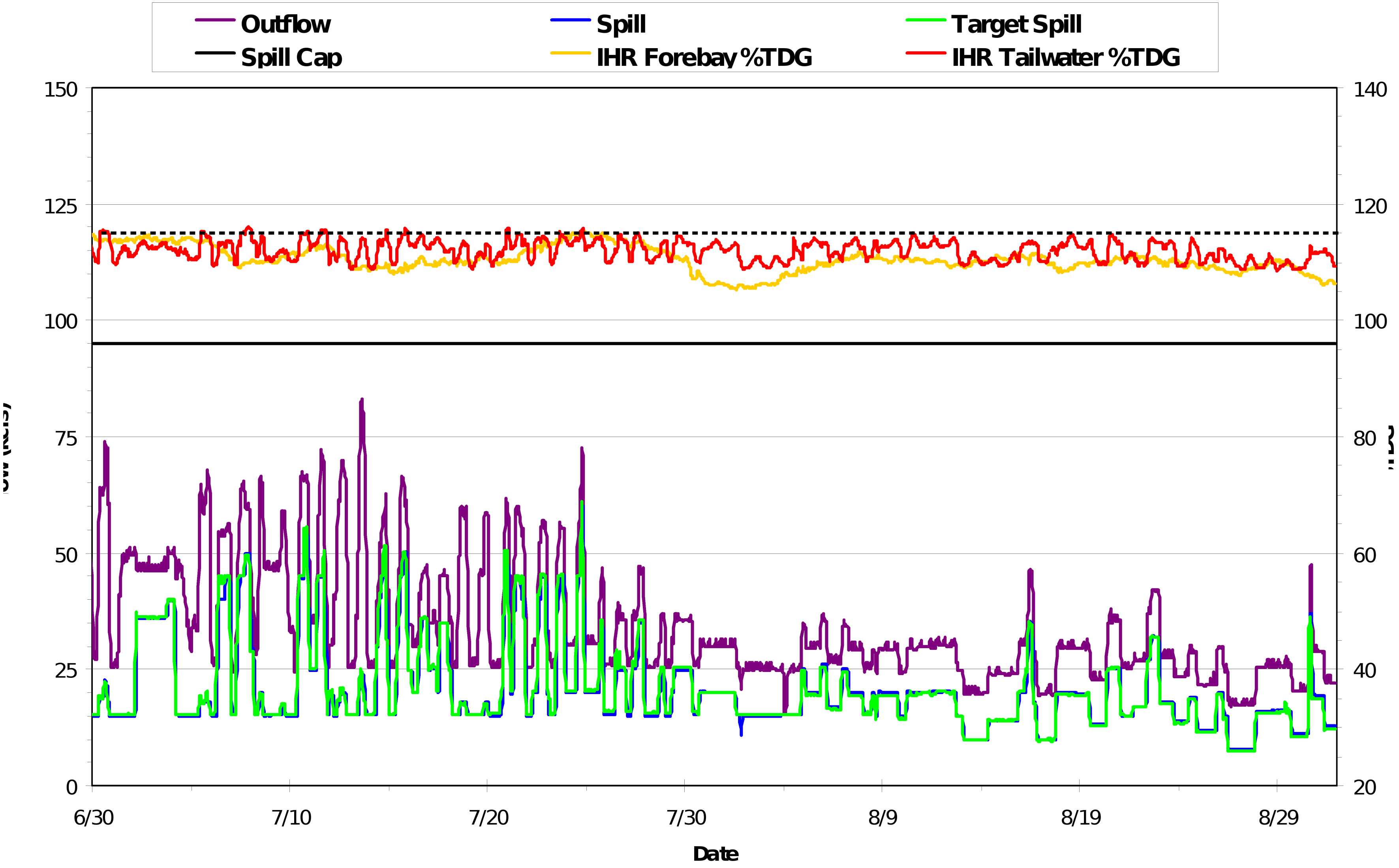
Spring Spill - Ice Harbor Dam



Target Spill = Quantity of Spill specified in the Fish Passage Implementation Plan.

Spill Cap = Maximum amount of spill that will keep TDG levels below State TDG Criteria.

Spring Spill - Ice Harbor Dam



Target Spill = Quantity of Spill specified in the Fish Passage Implementation Plan.
Spill Cap = Maximum amount of spill that will keep TDG levels below State TDG Criteria.

Ice Harbor
2006 Spill Stats

Parameter	Ice Harbor Forebay (IHRA)	Ice Harbor Tailwater (IDSW)	McNary Forebay (MCNA)
Number of High 12-hr %TDG Exceedances	51	22	31
Number of Exceedances of 125% TDG Criteria	0	32	0
Peak %TDG	124.9	126.3%	119.8%
Hours TDG:	---	---	---
> 110%	2942 (81.2%)	3361 (92.7%)	2036 (56.2%)
> 115%	1041 (28.7%)	2002 (55.2%)	607 (16.7%)
> 120%	145 (4.0%)	403 (11.1%)	0 (0.0%)
> 125%	0 (0.0%)	32 (0.9%)	0 (0.0%)
> 130%	0 (0.0%)	0 (0.0%)	0 (0.0%)
> 135%	0 (0.0%)	0 (0.0%)	0 (0.0%)

McNary Spill Activities in 2006

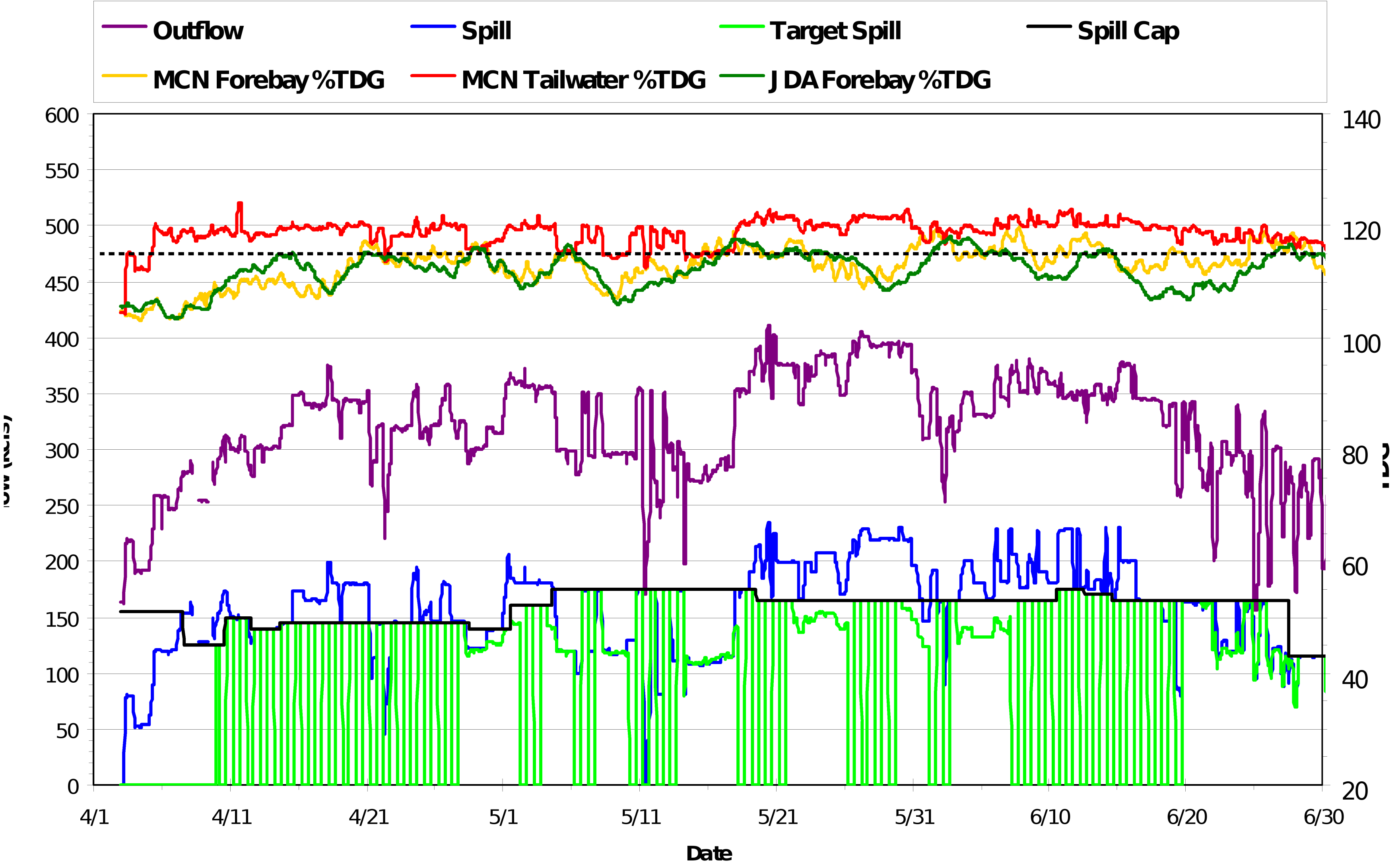
2006 Fish Passage Implementation P

- Spring Spill (April 10 – June 30)
  - April 10 – April 22:
    - Daytime (0500-1800 hrs) – 0 kcfs
    - Nighttime (1800-0500 hrs) – To the Spill Cap
  - April 23 – June 19:
    - Alternate between 40% of Outflow, 24 hrs/day and

      0 kcfs daytime/To the Spill Cap at night

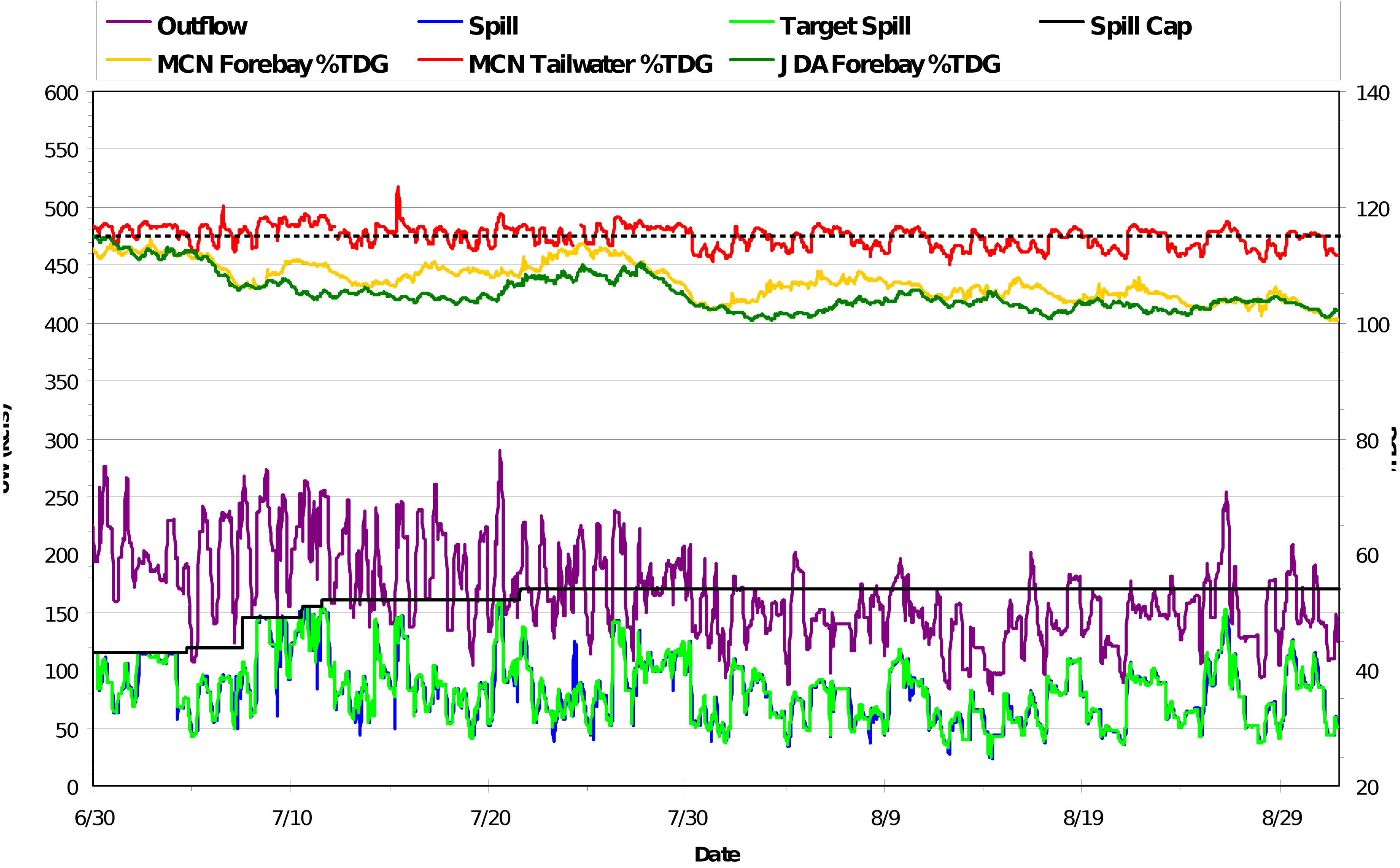
- Summer Spill (June 20 – August 31)
  - Alternate between 40% and 60% of Outflow (up to the spill cap).

2006 Spring Spill - McNary Dam



Target Spill = Quantity of Spill specified in the Fish Passage Implementation Plan.
Spill Cap = Maximum amount of spill that will keep TDG levels below State TDG Criteria.

Summer Spill - McNary Dam



Target Spill = Quantity of Spill specified in the Fish Passage Implementation Plan.

Spill Cap = Maximum amount of spill that will keep TDG levels below State TDG Criteria.

McNary
2006 Spill Stats

Parameter	McNary Forebay (MCNA)	McNary Tailwater (MCPW)	John Day Forebay (JDY)
Number of High 12-hr %TDG Exceedances	31	32	20
Number of Exceedances of 125% TDG Criteria	0	0	0
Lower Granite Tailwater Peak %TDG	119.8%	124.1%	118.1%
Hours TDG:	---	---	---
> 110%	2036 (56.2%)	3602 (99.4%)	1678 (46.3%)
> 115%	607 (16.7%)	2784 (76.8%)	377 (10.4%)
> 120%	0 (0.0%)	551 (15.2%)	0 (0.0%)
> 125%	0 (0.0%)	0 (0.0%)	0 (0.0%)
> 130%	0 (0.0%)	0 (0.0%)	0 (0.0%)
> 135%	0 (0.0%)	0 (0.0%)	0 (0.0%)

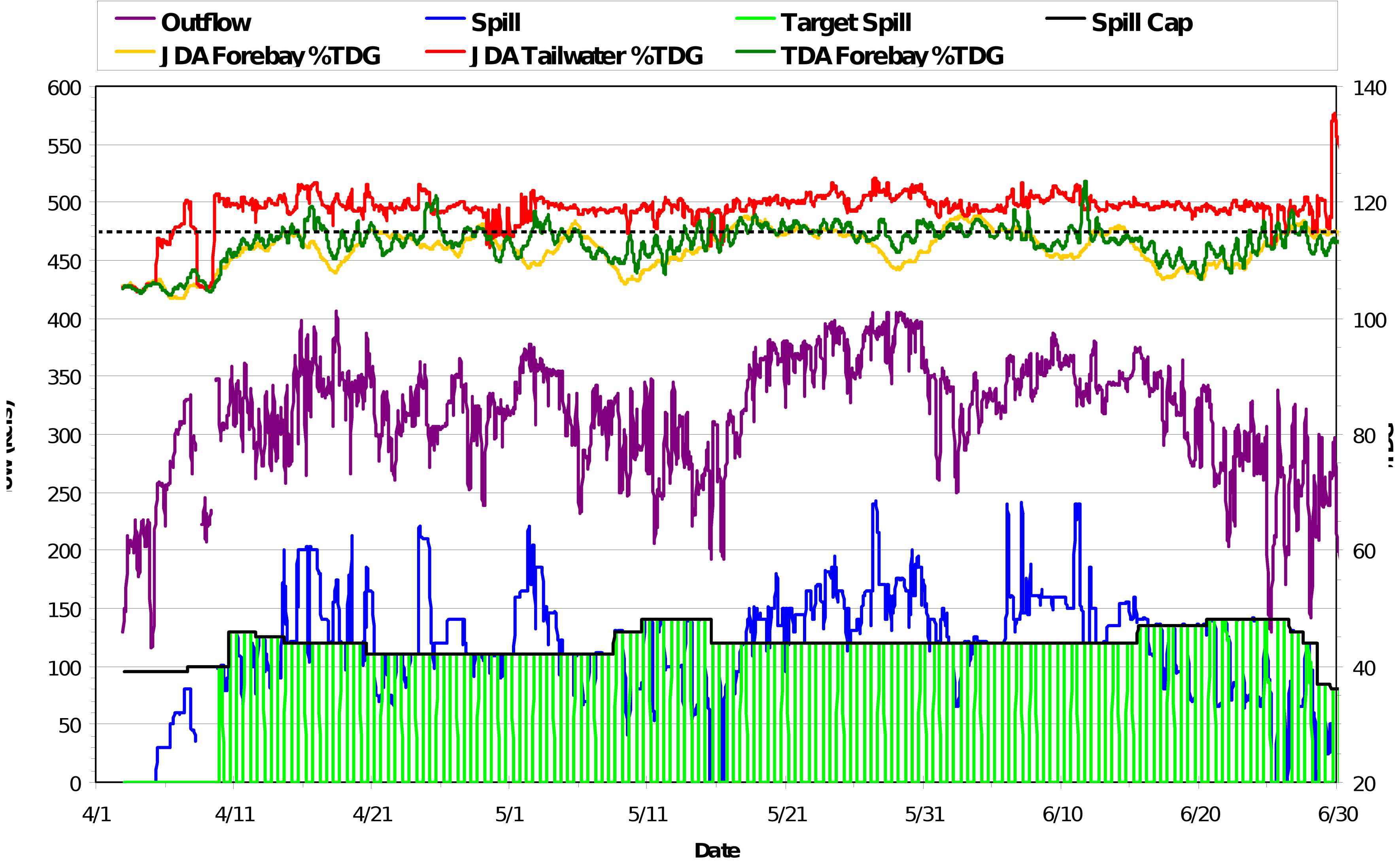
John Day Spill Activities in 2006

2006 Fish Passage Implementation P

- Spring Spill (April 3 – June 30)
  - ❖ Daytime (0600-1800 hrs) – 0 kcfs
  - ❖ Nighttime (1800-0600 hrs) – 60% of Outflow.

- Summer Spill (June 21 – August 31)
  - ❖ 30% of outflow 24 hrs/day.

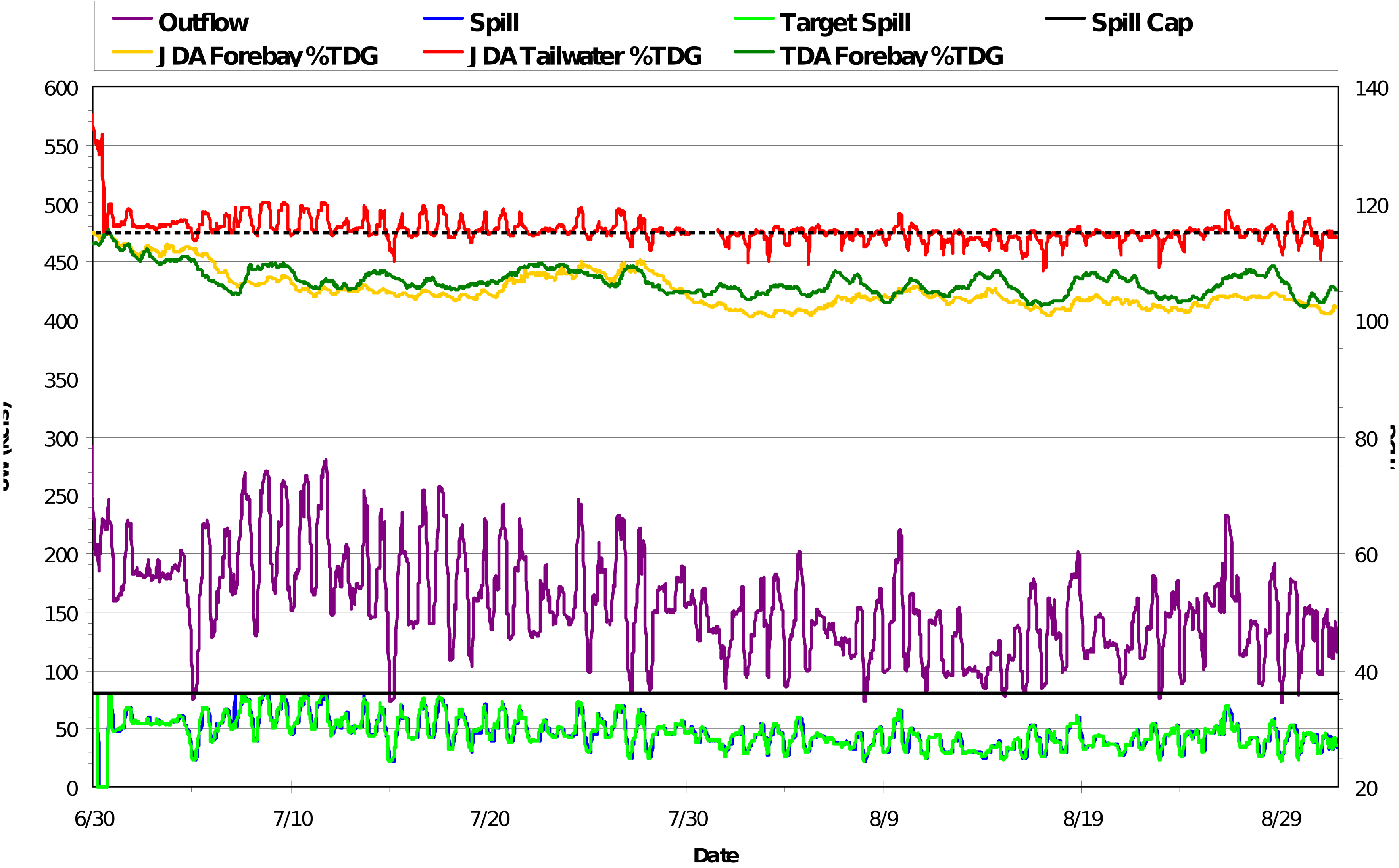
2006 Spring Spill - John Day Dam



Target Spill = Quantity of Spill specified in the Fish Passage Implementation Plan.

Spill Cap = Maximum amount of spill that will keep TDG levels below State TDG Criteria.

2006 Summer Spill - John Day Dam



Target Spill = Quantity of Spill specified in the Fish Passage Implementation Plan.

Spill Cap = Maximum amount of spill that will keep TDG levels below State TDG Criteria.

US ARMY CORPS OF ENGINEERS
NORTHWESTERN DIVISION

John Day
2006 Spill Stats

Parameter	John Day Forebay (JDY)	John Day Tailwater (MCPW)	The Dalles Forebay (TDA)
Number of High 12-hr %TDG Exceedances	20	38	40
Number of Exceedances of 125% TDG Criteria	0	0	0
Peak %TDG	118.1%	124.2%	123.6%
Hours TDG:	---	---	---
> 110%	1678 (46.3%)	3498 (96.5%)	1933 (53.3%)
> 115%	377 (10.4%)	2759 (76.1%)	584 (16.1%)
> 120%	0 (0.0%)	615 (17.0%)	14 (0.4%)
> 125%	0 (0.0%)	0 (0.0%)	0 (0.0%)
> 130%	0 (0.0%)	0 (0.0%)	0 (0.0%)
> 135%	0 (0.0%)	0 (0.0%)	0 (0.0%)

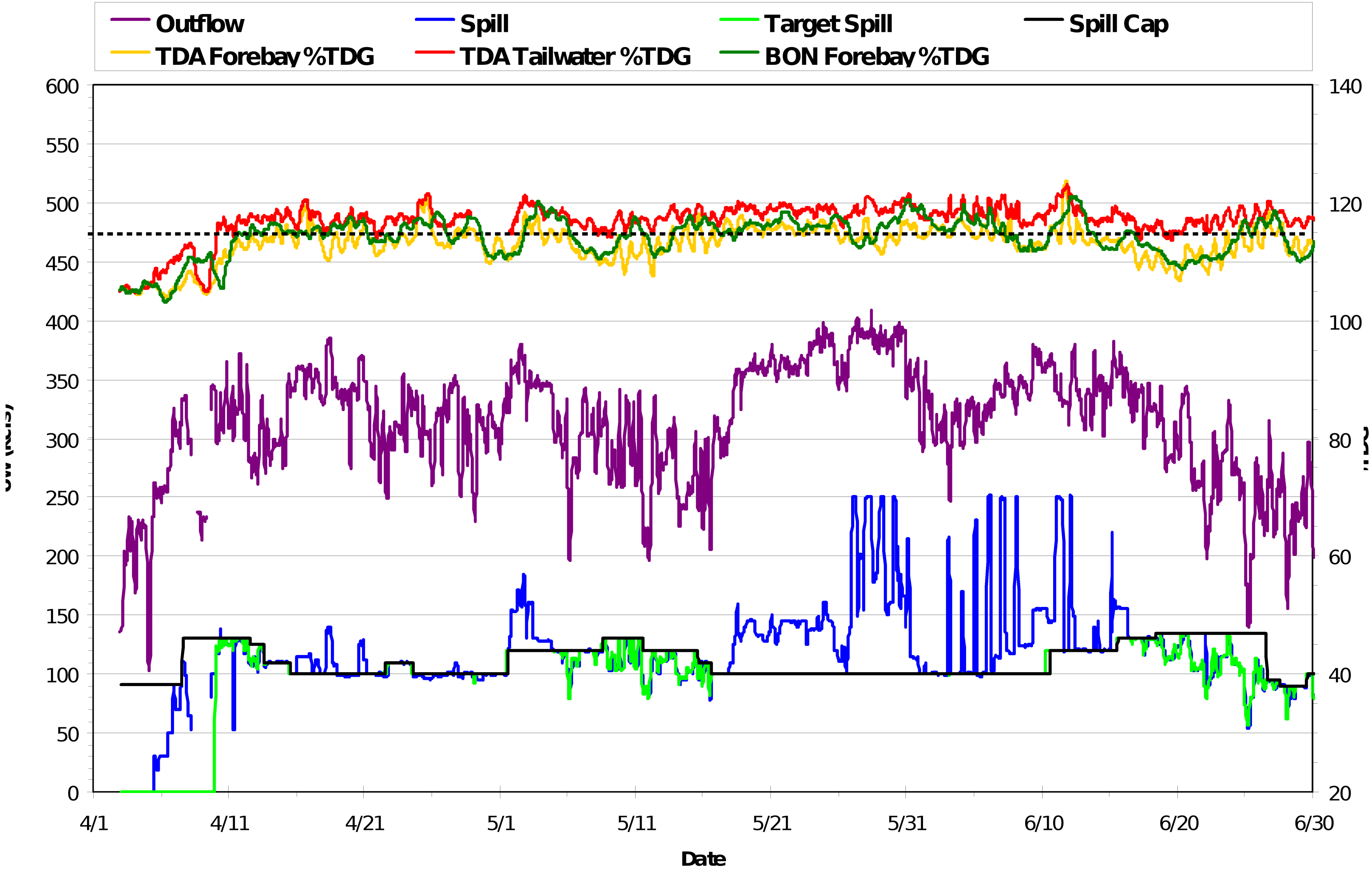
The Dalles Spill Activities in 2006

2006 Fish Passage Implementation P

- Spring Spill (April 3 – June 30)
  - ❖40% of Outflow, 24 hrs/day

- Summer Spill (July 1 – August 31)
  - ❖40% of Outflow, 24 hrs/day

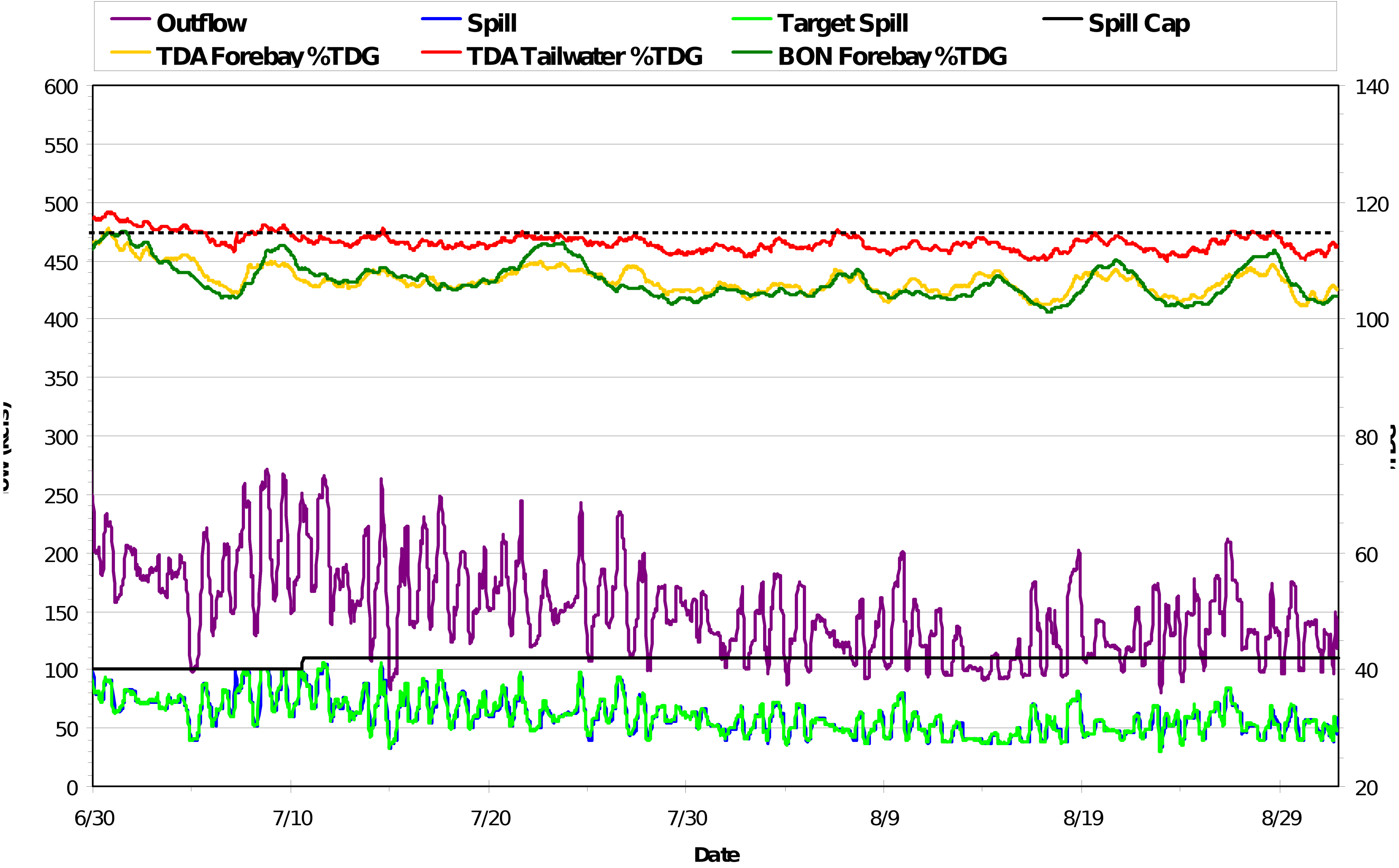
2006 Spring Spill - The Dalles Dam



Target Spill = Quantity of Spill specified in the Fish Passage Implementation Plan.

Spill Cap = Maximum amount of spill that will keep TDG levels below State TDG Criteria.

2006 Summer Spill - The Dalles Dam



Target Spill = Quantity of Spill specified in the Fish Passage Implementation Plan.

Spill Cap = Maximum amount of spill that will keep TDG levels below State TDG Criteria.

The Dalles
2006 Spill Stats

Parameter	The Dalles Forebay (TDA)	The Dalles Tailwater (TDDO)	Bonneville Forebay (BON)
Number of High 12-hr %TDG Exceedances	40	10	51
Number of Exceedances of 125% TDG Criteria	0	0	0
Peak %TDG	123.6%	123.1%	121.1%
Hours TDG:	---	---	---
> 110%	1933 (53.3%)	3434 (94.8%)	2141 (59.1%)
> 115%	584 (16.1%)	1974 (54.5%)	1005 (27.7%)
> 120%	14 (0.4%)	121 (3.3%)	33 (0.9%)
> 125%	0 (0.0%)	0 (0.0%)	0 (0.0%)
> 130%	0 (0.0%)	0 (0.0%)	0 (0.0%)
> 135%	0 (0.0%)	0 (0.0%)	0 (0.0%)

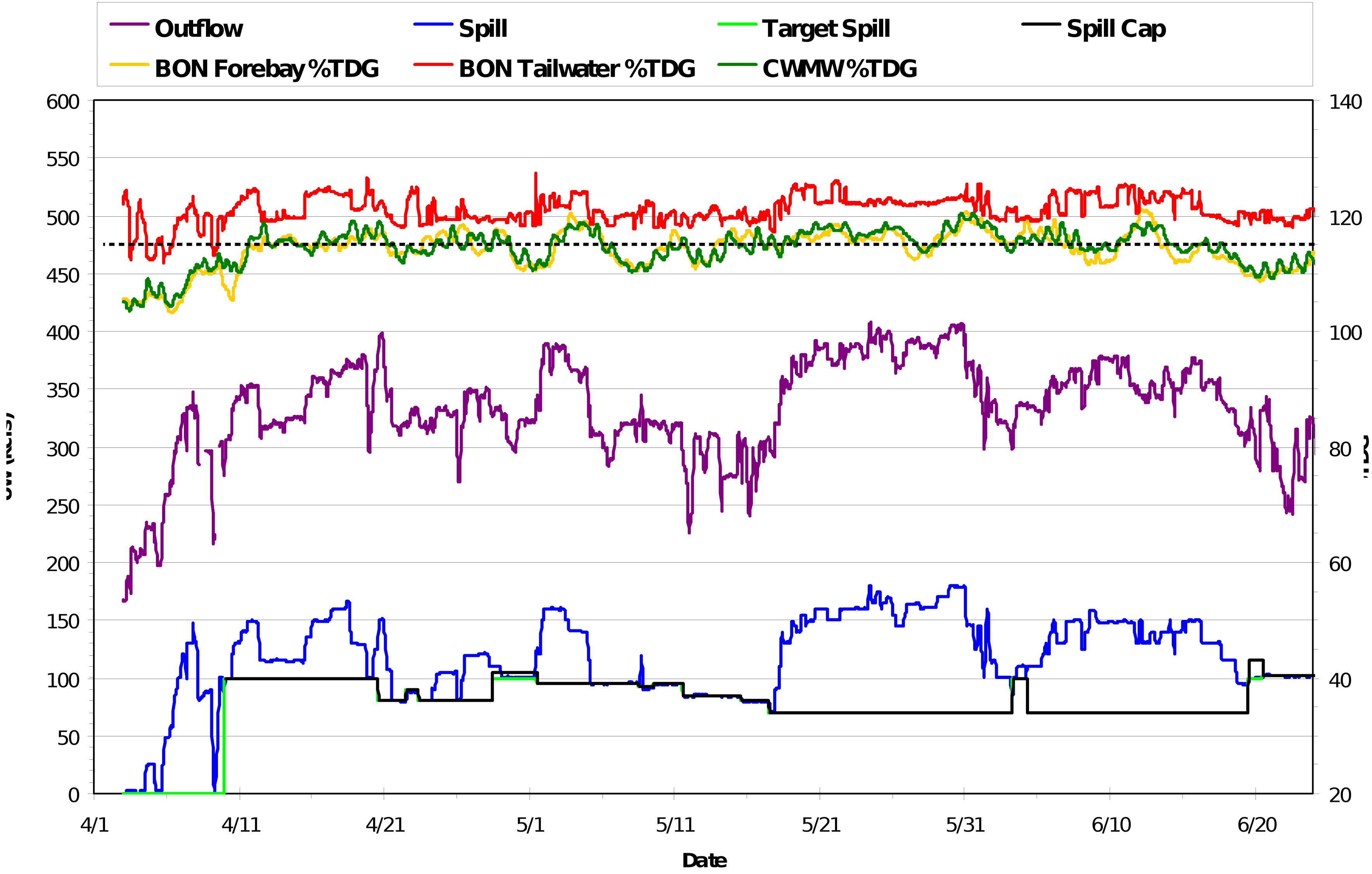
Bonneville Spill Activities in 2006

2006 Fish Passage Implementation P

- Spring Spill (April 10 – June 30)
  - ❖To the Spill Cap up to 100 kcfs.

- Summer Spill (July 1 – August 31)
  - ❖Daytime: 75 kcfs
  - ❖Nighttime: To the Spill Cap

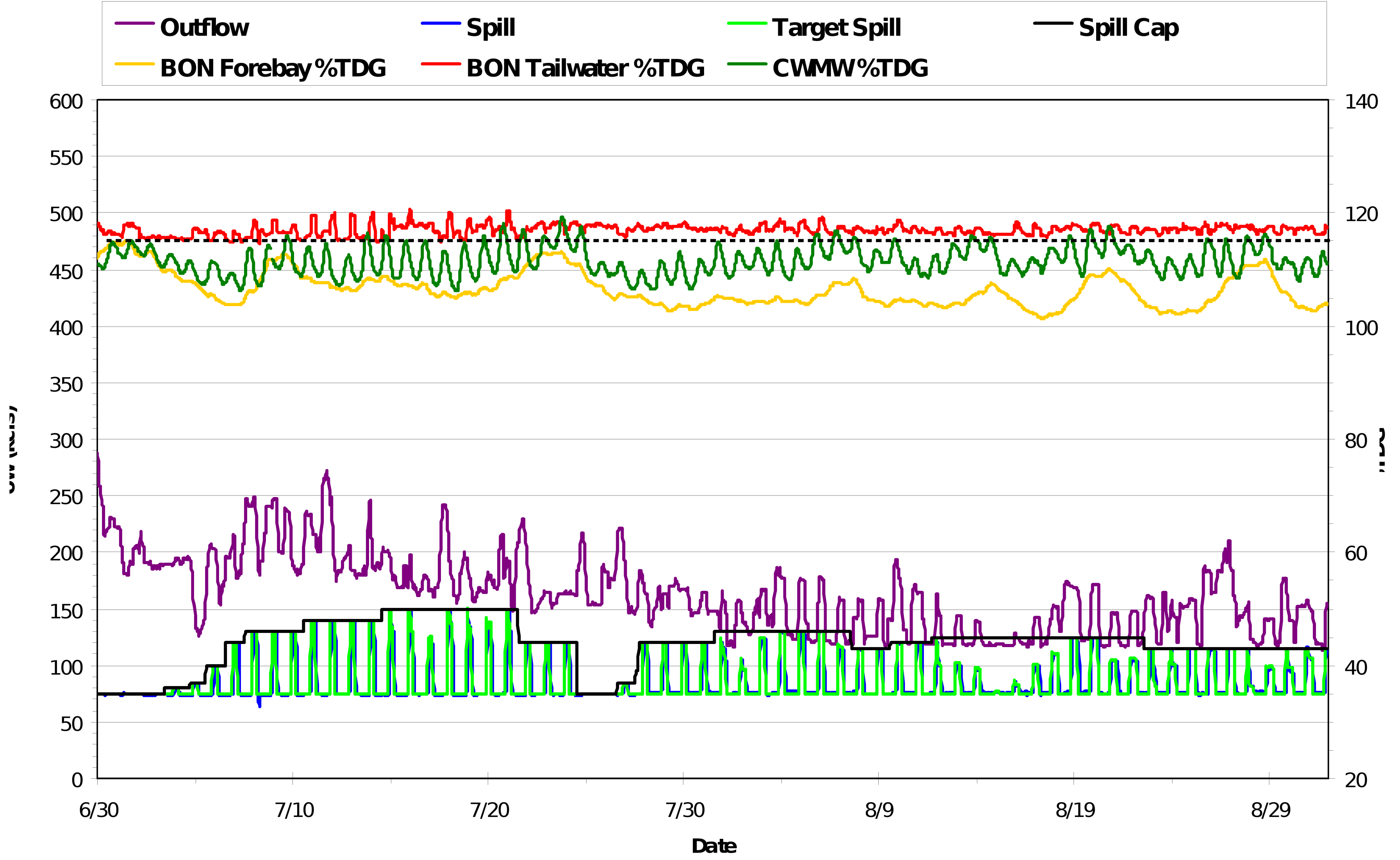
2006 Spring Spill - Bonneville Dam



Target Spill = Quantity of Spill specified in the Fish Passage Implementation Plan.

Spill Cap = Maximum amount of spill that will keep TDG levels below State TDG Criteria.

2006 Summer Spill - Bonneville Dam



Target Spill = Quantity of Spill specified in the Fish Passage Implementation Plan.
Spill Cap = Maximum amount of spill that will keep TDG levels below State TDG Criteria.

Bonneville
2006 Spill Stats

Parameter	Bonneville Forebay (BON)	Bonneville Tailwater (CCIW)	Camas-Washougal (CWMW)
Number of High 12-hr %TDG Exceedances	51	61	63
Number of Exceedances of 125% TDG Criteria	0	0	0
Lower Granite Tailwater Peak %TDG	121.1%	127.5%	120.5%
Hours TDG:	---	---	---
> 110%	2141 (59.1%)	3624 (100.0%)	3018 (83.3%)
> 115%	1005 (27.7%)	3568 (98.5%)	1149 (31.7%)
> 120%	33 (0.9%)	1179 (32.5%)	11 (0.3%)
> 125%	0 (0.0%)	64 (1.8%)	0 (0.0%)
> 130%	0 (0.0%)	0 (0.0%)	0 (0.0%)
> 135%	0 (0.0%)	0 (0.0%)	0 (0.0%)